# RECOVERY OF SAWN TIMBER FROM ACCELERATED KILN DRYING

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**ABSTRACT**

Forest Research Institute Malaysia (FRIM) has always been working in tandem with the respective stakeholders from wood-based sectors for the advancement of indigenous and innovative wood processing technologies. To address some of the concerns raised by the wood-based industries, FRIM has taken an initiative to develop a green and accelerated drying technology for rubberwood, by adopting the principle of high temperature drying-cum-heat treatment approach. This paper discussed the recovery of quality accelerated throughput of rubberwood dried under high temperature condition. Freshly sawn rubberwood lumber was dried at dry bulb temperature of 130°C from green condition in a 14 $m^3$ capacity high temperature drying system. The timber stacks for the trial were made up of 90cm- and 180cm-long dimension sawn measuring at approximately 30mm in thickness and 100mm in width. For the drying trial, five percent sampling method were carried out based on the total kiln charge, of which thirty pieces of sample boards were obtained equally from these two sawn length groups respectively. The sample boards of mixed sawn type were randomly selected, but systematically placed within the timber box-stacked bundles at specific stack-heights. The initial and final moisture content of the sample boards was determined. The initial moisture content of sample boards used in this study was ranged from 44.26 to 78.10%. The kiln charge was dried down to a targeted moisture content of approximately 4 to 6%. After drying, recovery study was carried out for the whole kiln charge. The recovery for the sawn length group of 90cm were processed into usable lengths of 90cm (original length retained with no adverse drying defects), 60cm, 45cm and 20cm respectively. Whereas, the recovery for the sawn length group of 180cm were processed into usable lengths of 180cm (original length retained with no adverse drying defects), 150cm, 120cm, 90cm, 60cm, 45cm and 20cm respectively. The findings showed that volume recovery for sawn length group of 180cm was 71.21% compared to the shorter length group of 64.12%. Out of the total volume recovered for sawn length group of 180cm, approximately 60.82% was of sawn length of 90-180cm, with the breakdown of 32.80% (180cm), 4.24% (150cm), 7.22% (120cm) and 16.56% (90cm) respectively, for each of the recovered length in this sub-group. Hence, better volume and grade recovery can be achieved by drying longer length timber especially for species such as rubberwood, which is prone to various warpings during drying due to its inherent growth characteristics.

**Key words:** accelerated drying, recovery, kiln drying, high temperature

## INTRODUCTION

Forest Research Institute Malaysia (FRIM) has always been working in tandem with the respective stakeholders from wood-based sectors for the advancement of indigenous and innovative wood processing technologies. To address some of the concerns raised by the wood-based industries, FRIM has taken an initiative to develop a green and accelerated drying technology for rubberwood, by adopting the principle of high temperature drying-cum-heat treatment approach.

In general, drying timber at high temperature refers to dry bulb temperatures (DBTs) of 100°C or higher, usually from 110 to 121°C (230 to 250°F) (Boone 1984). Reduction in drying time, resulting in lower mill operating cost (Milota 2000) and energy consumption (Bekhta and Niemz 2003) and improvement in some drying-associated problems such as reduction in surface checks (Obataya *et al.* 2006, Katagiri *et al.* 2007) and twist (Frühwald 2007) are among the many advantages that have driven the practice of drying timbers at high temperature (HT). Besides, high temperature-dried timber has improved dimensional stability compared to conventionally treated rubberwood (Zahidah et al. 2020).

In previous study, the moisture content dispersion of rubberwood within individual boards were assessed after high temperature drying at 130°C (Sik et al. 2015). It was found that the high-temperature dried rubberwood samples were able to dry uniformly throughout the timber and the moisture content variation between the inner and outer layers were within 1.5% after conditioning treatment which was carried out before the end of drying.

In general, timber recovery is the main indicator for a successful mill operation as it determines the production capacity and revenue generated by the timber processing plant (Zahidah et al. 2019). A good drying regime can help to increase the timber recovery as it will minimize the occurrence of wood defects such as warping, bowing and checks. Besides that, timber dimensions also influence the recovery of timber after drying especially for species such as rubberwood, which is prone to various defects during drying due to its inherent growth characteristics. This paper further discussed the recovery of quality accelerated throughput of rubberwood dried under high temperature condition.

## MATERIAL AND METHODS

Freshly sawn rubberwood lumber was dried at dry bulb temperature of 130°C from green condition in a 14 $m^3$ capacity high temperature drying system. The timber stacks for the trial were made up of 90cm- and 180cm-long dimension sawn measuring at approximately 30mm in thickness and 100mm in width.

For the drying trial, five percent sampling method were carried out based on the total kiln charge, of which thirty pieces of sample boards were obtained equally from these two sawn length groups respectively. Prior to stacking, the sample boards were inserted with thermocouple wire for monitoring of internal wood temperature during drying for optimization of the process parameters (Figure 1).The sample boards of mixed sawn type were randomly selected, but systematically placed within the timber box-stacked bundles at specific stack-heights (Figure 2). The initial and final moisture content of the sample boards was determined.

Figure 1. Sample boards from both sawn length-groups inserted with thermocouple wire for monitoring of internal wood temperature during drying process.

Figure 2. Sample boards with inserted thermocouples, systematically placed in within the box-stacked timber bundles at specific stack-heights.

After drying, the recovery for the sawn length group of 180cm were conducted by cross-cutting the individual timber plank into usable lengths of either 180cm with its original length retained (free of adverse drying defects), or mixed lengths of 150cm, 120cm, 90cm, 60cm, 45cm and 20cm respectively. Whereas, the sawn length group of 90cm were cross-cut into usable lengths of either 90cm with its original length retained, or mixed lengths of 60cm, 45cm and 20cm respectively. Timber planks will be regarded as rejects when they were deemed totally unusable and non-recoverable due to severe drying defects such as serious internal checks and splits along the timber length

## RESULTS AND DISCUSSION

The initial moisture content of sample boards used in this study was ranged from 44.26 to 78.10%. The kiln charge was dried down to a targeted moisture content of approximately 4 to 6%. After drying, recovery study was carried out for the whole kiln charge. The width and thickness shrinkages of the high temperature processed material were ranged from 1.70 to 4.67% and 1.44 to 4.86%, respectively.

### Volume recovery based on total timber input per kiln charge

After drying, recovery study was conducted to assess the quality of dried timber by visual inspection for drying defects such as surface checks, end splits and various forms of warpings. This preliminary assessment was to identify the drying defects before the dried timber was segregated for further processing into various usable lengths, by maximising the yields' recovery of the respective timber planks.

Table 1. showed that the average recovery of dried rubberwood was 68.25% from these two sawn-length groups under the same kiln charge. Recovery assessment was carried out according to individual length-group, and the total timber output recovery obtained was 64.12% and 71.21% for individual sawn timber-length groups of 90cm and 180cm respectively. The longer length-group has relatively higher volume recovery by 7.01% compared to the shorter-length-group.

**Table 1. The recovery of kiln-dried rubberwood from two sawn-length groups**

| Length-group (cm) | Timber Input, Vol. ($m^3$) | Timber Output, Vol. ($m^3$) | Recovery based on individual group (%) |
|---|---|---|---|
| 90 | 1.701 | 1.091 | 64.12 |
| 180 | 2.381 | 1.696 | 71.21 |
| Total | 4.082 | 2.787 | |

**Volume recovery of sawn rubberwood according to specific sawn lengths**

In general, dried sawn timber will be further processed based on its overall dimension measurement of length, width and thickness. In this study, the recovery of timber was primarily based on length recovery for comparing the drying yield of mixed-length timbers.

Table 2. showed that out of the total volume recovered for sawn length group of 180cm, approximately 60.83% was of sawn length of 90-180cm, with the breakdown of 32.80% (180cm), 4.24% (150cm), 7.22% (120cm) and 16.56% (90cm) respectively, for each of the recovered length in this sub-group. Whereas, the shorter length group has high proportion of recovered timber volume from sawn-length of 20-60cm, which made up of approximately 62.87% of the total volume recovered for the 90cm length-group (Table 3.).

**Table 2. The recovery of kiln-dried rubberwood according to usable length(s) for 180cm-long sawn rubberwood**

| Sawn length (cm) | 180 | 150 | 120 | 90 | 60 | 45 | 20 | Reject | Waste (off cuts) |
|---|---|---|---|---|---|---|---|---|---|
| Volume Recovery ($m^3$) | 0.556 | 0.072 | 0.122 | 0.281 | 0.455 | 0.180 | 0.029 | 0.016 | 0.686 |
| Recovery (%) | 23.36 | 3.02 | 5.14 | 11.79 | 19.12 | 7.54 | 1.24 | 0.68 | 28.11 |
| Breakdown of recovered timber according to length (%) | 32.80 | 4.24 | 7.22 | 16.56 | 26.86 | 10.59 | 1.73 | - | - |

**Table 3. The recovery of kiln-dried rubberwood according to usable length(s) for 90cm-long sawn rubberwood**

| Sawn length (cm) | 90 | 60 | 45 | 20 | Reject | Waste (off cuts) |
|---|---|---|---|---|---|---|
| Volume Recovery ($m^3$) | 0.405 | 0.335 | 0.285 | 0.066 | 0.019 | 0.610 |
| Recovery (%) | 23.81 | 19.68 | 16.75 | 3.88 | 1.11 | 34.77 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Breakdown of recovered timber according to length (%)** | 37.13 | 30.70 | 26.12 | 6.05 | - | - |

In this study, recovery for the dried sawn rubberwood was down to the shortest usable length that can be obtained, and which is generally acceptable by the industry for further downstream processing such as finger-jointing production. Hence, rejects due to the relatively shorter timber length of below 20cm (8"), usually will be regarded as off cuts and salvaged to be utilised as fuel for biomass boiler. On the other hand, the higher the recovery for dried sawn timber length of 20cm and up, the higher will be for the product profit margin per unit production, as these 'usable' lengths will be further processed into value-added products such as high end joineries and finger-jointed components.

## CONCLUSIONS

Generally, the long-length sawn group of 180cm-long rubberwood recorded better recovery than the 90cm-long rubberwood sawn, dried under the same kiln charge based on the timber input volume respectively. Hence, better volume and grade recovery can be achieved by drying longer length timber especially for species such as rubberwood, which is prone to various warpings during drying due to its inherent growth characteristics. In addition, box-stacked timber bundles made up of long length timber are more stable and handling of such timber during stacking can be done in a relatively efficient manner compared to the shorter length timber in this study.

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