

# Fiber Saturation Point of Several Indonesian Lesser Known Species

Imam Wahyudi, Arif R Harijadi

Departemen Hasil Hutan, Fakultas Kehutanan, Institut Pertanian Bogor  
Kampus IPB Darmaga Bogor

*Corresponding outhor:* email imyudarw@yahoo.com (Imam Wahyudi)

## Abstract

Fiber saturation point (FSP) of several Indonesian commercial wood species was studied comprehensively. Five wood species namely sengon (*Paraserianthes falcataria*), gmelina (*Gmelina arborea*), nangka (*Artocarpus heterophyllus*), manii (*Maesopsis eminii*), and mangium (*Acacia mangium*) from plantation areas closed to Bogor Agricultural University (IPB) campus were used as the sample. From each species, one normal tree was selected then cut, and one hundred and twenty small healthy blocks of (1 x 1 x 0.5) cm<sup>3</sup> were extracted randomly and utilized for specific gravity (SG) and wood shrinkage -green to air dry and to oven dry conditions- measurement. FSP was then measured as a ratio of total volumetric shrinkage and the SG. It was showed that FSP was affected by species namely extractive content. In all species studied, average value of FSP was below 30%. FSP of sengon, gmelina, nangka, manii, and mangium in average was 26.41%, 16.92%, 14.49%, 22.31%, and 23.94%, respectively.

**Key words:** Fiber saturation point (FSP), sengon, gmelina, nangka, manii, and mangium.

## Introduction

Fiber saturation point (FSP) represents the maximum moisture that wood may adsorb from atmospheric vapors assuming that no condensation occurs. It is a critical point of wood during drying. If moisture content of wood decreases below the FSP the wood will shrink, and on the other hand if it increases under the range of FSP the wood will swell. These changes will result in the changes of wood properties. Therefore, understanding the FSP in each species is very useful and important from a practical point of view, because most properties and drying quality change when the moisture content of wood is below this point (Tsoumis 1991).

Research on FSP of Indonesian lesser known species is very limited. So, such kind of research should be started immediately. Using the correct of FSP,

drying quality and most wood properties will be improved due to minimum in checks, shakes, and other distortions. Based on these phenomena, therefore, this study was carried out in order to investigate the FSP of several lesser known species as well as to evaluate effect of species on the FSP as a preliminary. Besides improving the efficiency of wood utilization as raw material, the study will also retain our natural forest resources indirectly.

## Materials and Methods

A hundred and twenty small green-wood healthy blocks of (1 x 1 x 0.5) cm<sup>3</sup> of sengon (*Paraserianthes falcataria*), gmelina (*Gmelina arborea*), nangka (*Artocarpus heterophyllus*), manii (*Maesopsis eminii*) and mangium (*Acacia mangium*) were used as samples. Wood blocks were extracted randomly from one

log of each species. The edge of all samples was cut precisely along with longitudinal, radial and tangential directions. Table 1 shows the

characteristics of wood samples namely moisture content (MC) in two conditions (green and air dry), as well as its drying rate from green to air dry condition.

Table 1 Characteristics of wood samples

Species	Green MC (%)	Air dry MC (%)	Δ MC (%)	Drying rate (% per day)
<i>P. falcataria</i>	90.32	15.32	75.00	2.50
<i>G. arborea</i>	40.14	15.56	24.58	0.80
<i>A. heterophyllus</i>	51.43	15.51	35.92	1.20
<i>M. eminii</i>	112.78	15.65	97.13	3.20
<i>A. mangium</i>	48.34	15.48	22.86	0.80

### Specific gravity determination

Specific gravity of wood (SG) was determined using Gravimetric method. Wood volume (VB) was measured following standard procedure of Archimedes. After measuring the volume, wood sample was kept inside a laboratory scale of oven of  $(103 \pm 2)^\circ\text{C}$  for 4 h and then measured for its constant weight (BKT). SG was then obtained by formula:

$$SG = \frac{(BKT)}{VB} / \text{density of water}$$

### Total volumetric shrinkage of wood measurement

Total shrinkage is shrinkage from green-to oven-dry- condition. In this study, total volumetric shrinkage (SV) was measured using the formula of Skaar (1972) as followed:

$$SV = \%S_L + \%S_T + \%S_R - (0.01) (\%S_R) (\%S_T).$$

Each dimensional shrinkage (DS) namely longitudinal- ( $S_L$ ), radial- ( $S_R$ ), and tangential-shrinkages ( $S_T$ ) was measured using the formula:

$$DS = \frac{(D1 - D2)}{D1} \times 100\%,$$

where D1 is dimensional of wood in green condition, while D2 is in oven dry condition.

### FSP measurement

FSP was measured following the formulas of Kollmann & Cöte (1968), Skaar (1972), Panshin & de Zeew (1980), Tsoumis (1991), as well as FPL Technical (1999) as followed:

$$FSP = \frac{(SV)}{SG}$$

### Data analysis

Data was calculated to obtain its average and deviation standard values. The average value was then compared to that of the references.

## Results and Discussion

### SG of wood

Average values of SG based on oven dry weight and green volume were tabulated in Table 2.

From Table 2 it showed that SG was differed and influenced by species, probably by differences in cell wall thickness, density and extractive content. The value ranged from 0.32 (sengon) to 0.55 (nangka). Based on the average value of SG, wood species used in this study could be classified as low- (sengon, mangium, and manii), medium- (gmelina), and high- strength (nangka).

Compared to the reference used it showed that only SG of mangium was not suitable, perhaps due to the differences in age of tree. Since our sample was from 6 years old tree, the density is lower than that of the references. According to Panshin & de Zeew (1980), quality of wood from the younger tree is inferior to that of the older one.

There was an interesting phenomenon found in this study i.e. correlation between drying rate (Table 1) and SG (Table 2). According to Tsoumis (1991), drying rate of smaller SG-wood should be higher than that of the bigger one. However, our result showed different phenomenon i.e. drying rate of mangium (SG = 0.34) is lower than that of nangka (SG = 0.55), but similar to that of gmelina (SG = 0.48). This will be examined in our next research in order to find out the affecting factors.

### Total volumetric shrinkage

Average value of volumetric shrinkage was tabulated in Table 3. It showed that volumetric shrinkage from green to air dry

condition as well as from green to oven dry condition was almost similar in all species. It ranged from 2.26-3.52% (the former) and 7.97-8.45% (the latter). The highest was found in sengon (3.52% from green to air dry and 8.45% from green to oven dry condition, respectively), and the lowest was in nangka (2.26% from green to air dry and 7.97% from green to oven dry condition, respectively). According to Tsoumis (1991) as well as Coto (2004), variation in wood shrinkage is resulted from variation in wood density, SG, extractive content, chemical composition, and also wood shape and size which will affect the orientation and moisture content of wood.

Linear correlation between shrinkage and SG as noted by Stamm (1972) and Tsoumis (1991) was not also found in this study. Volumetric shrinkage of sengon (SG = 0.32) is higher compared to that of nangka (SG = 0.64) as well as gmelina (SG = 0.48). This phenomenon is probably related to the variability of extractive content because it will reduce wood shrinkage and also its chemical composition.

Compared to manii (SG = 0.36), volumetric shrinkage of mangium (SG = 0.34) is higher. This is probably related to the juvenile wood portion inside mangium. Greater portion of juvenile wood will resulted in the higher magnitude of volumetric shrinkage.

Table 2 Average value of SG

Species	SG of wood	
	Present study	References <sup>*)</sup>
<i>P. falcataria</i>	0.32 ± 0.06	0.28-0.35
<i>G. arborea</i>	0.48 ± 0.04	0.41-0.50
<i>A. heterophyllus</i>	0.55 ± 0.12	0.51-0.75
<i>M. eminii</i>	0.36 ± 0.05	0.35-0.48
<i>A. mangium</i>	0.34 ± 0.14	0.57-0.60

\*) Source: www2.fpl.fs.fed.us

Table 3 Average value of volumetric shrinkage

Species	Volumetric Shrinkage (%)	
	Green to air dry	Green to oven dry
<i>P. falcataria</i>	3.52	8.45
<i>G. arborea</i>	3.07	8.12
<i>A. heterophyllus</i>	2.26	7.97
<i>M. eminii</i>	2.58	8.03
<i>A. mangium</i>	3.33	8.14

Table 4 Total volumetric shrinkage: comparison between existing result and the reference

Species	Total Volumetric Shrinkage (%)	
	Present Study	Reference <sup>*)</sup>
<i>P. falcataria</i>	8.45	9.50
<i>G. arborea</i>	8.12	8.80
<i>A. heterophyllus</i>	7.97	8.40
<i>M. eminii</i>	8.03	8.00
<i>A. mangium</i>	8.14	1.40

\*) Source: [www2.fpl.fs.fed.us](http://www2.fpl.fs.fed.us)

From this study it was clear that total volumetric shrinkage of all species studied in average was lower than that of data from reference, except in manii (Table 4). This is perhaps related to the variation occurred in wood sample.

### FSP

Average value of FSP was tabulated in Table 5. It showed that FSP was differed and influenced by wood species. The value ranged from 14.49% (nangka) to

26.41% (sengon). FSP of manii (22.31%) was almost similar to that of mangium (23.94%), while FSP of gmelina was 1.92%. In general it showed that FSP of five species studied is below 30%.

Lower value of FSP in nangka and gmelina compared to those in manii, mangium and sengon, is probably correlated to extractive content. The presence of extractives reduces the FSP as noted by Tsoumis (1991).

Table 5 Average value of FSP

Species	FSP (%)	
	Present Study	Reference <sup>*)</sup>
<i>P. falcataria</i>	26.41 ± 1.32	24.36
<i>G. arborea</i>	16.92 ± 2.05	20.00
<i>A. heterophyllus</i>	14.49 ± 3.18	15.56
<i>M. eminii</i>	22.31 ± 1.88	20.52
<i>A. mangium</i>	23.94 ± 1.51	20.67

\*) [www2.fpl.fs.fed.us](http://www2.fpl.fs.fed.us) (calculated)

From the above table it can be seen that FSP of sengon, manii and mangium is bigger than those of references, while FSP of gmelina and nangka is smaller. Since the differences is small enough, except for gmelina, average value of FSP obtained in this study is similar to that of reference i.e. FSP in sengon is the biggest while in nangka is smallest.

Since average value of FSP in all species studied is lower than 30%, common value utilized by wood industry, it was no doubt that all existing drying schedule should be revised well. It seems that several Indonesian wood species will start to shrink if its moisture content is < 14.49% for nangka, < 16.92% for gmelina, < 22.31% for manii, < 23.94% for mangium, and < 26.41% for sengon, respectively.

### Conclusions

Average value of FSP for sengon, gmelina, nangka, manii, and mangium was 26.41%, 16.92%, 14.49%, 22.31%, and 23.94%, respectively.

FSP was influenced by wood species especially its extractive content.

### References

- Anonim. *Wood Anatomy*. [Http://www2.fpi.fs.fed.us](http://www2.fpi.fs.fed.us). [22 December 2008].
- Coto Z. 2004. Tingkat Stabilisasi Dimensi Delapan Jenis Kayu Indonesia. *J. Ilmu dan Teknologi Kayu Tropis* 2(1): 34-38.
- Forest Products Laboratory Technical. 1999. *Wood Handbook: Wood as an Engineering Material*. USA: USDA Forest Service. Forest Products Laboratory.
- Kollmann FFP, Cöte WA. 1968. *Principles of Wood Science and Technology*. Vol. I. Solid Wood. New York: Springer-Verlag.
- Panshin A, de Zeew C. 1980. *Textbook of Wood Technology*, 4-th Edition. New York: McGraw-Hill Book Co. Inc.
- Skaar C. 1972. *Water in Wood*. New York: State University College of Forestry at Syracuse University.
- Tsoumis G. 1991. *Science and Technology of Wood: Structure, properties, utilization*. New York: Van Nostrand Reinhold.

### Riwayat naskah (Article History)

Naskah masuk (*received*) : 21 September 2009  
Diterima (*accepted*) : 23 December 2009