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Fibre Saturation Point of Lesser-Known Timbers from Sabah

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ABSTRAK

Nilai takat tepu gentian beberapa spesis 'OT' dari negeri Sabah telah dikaji. 'OT' spesis merujuk kepada nama beberapa spesis kayu yang belum mempunyai nama dagangan atau spesies kayu yang belum terkenal. Semua 30 spesies kayu OT yang dikaji mempunyai julat nilai takat tepu gentian dari 17 - 33%. Nilai takat tepu gentian bagi kayu-kayu ini amat berguna dalam aspek pengeringan, pemprosesan dan penggunaan kayu secara umum.

ABSTRACT

The fibre saturation point (FSP) values of some 'OT' timbers from Sabah, Malaysia were evaluated. 'OT' is a term used to refer to a number of unidentified or unknown timbers and also some identified lesser known timbers of Sabah. The fibre saturation point values of these 30 species of OT timbers range from 17 - 33%. Determination of fibre saturation point in relation to OT wood properties is very useful in timber drying, conversion and timber utilization.

INTRODUCTION

Early in the 20th century, Tiemann (1906) introduced the term fibre saturation point in connection with his early work on strength-moisture relations. Since then, fibre saturation point has become the subject of numerous investigations. The concept of fibre saturation point is defined in terms of theoretical condition of wood when its cell cavities are completely devoid of water whilst the cell walls are saturated with water.

The natural transition point between bound water (water held with a force greater than that of water to water) and free water is of considerable interest in wood science as it represents the transition point of many important wood properties (Stamm 1964).

Nine methods for determining fibre saturation point were described by Stamm (1964). Four of these requires some extrapolation.

1. Moisture content adsorption isotherms to unit relative vapour pressure.
2. Differential heat of wetting: Moisture content plot to zero heat evolved.
3. Volumetric shrinkage-moisture content plot to zero shrinkage.
4. Another shrinkage involved determining the ratio of the total volumetric shrinkage to the green volume specific gravity and a correction for the average density of the absorbed water.

Two methods involved in determining the transition point due to the changing relationship:

5. Logarithm of electrical conductivity versus moisture content.
6. The logarithm of strength properties versus moisture content.

All of these require measurements over practically the full range of relative vapour pressure or moisture content. The remaining three, newer methods require a negligible reduction in vapour pressure.

7. The porous plate method, or no change in moisture content.
8. The non-solvent water technique.
9. The non-freezing water technique.

Nine methods for determining fibre saturation points of wood are given together with the limitations of each. The six older methods all depend upon making measurements over a broad range over a relative water vapour pressure or moisture content. They involve either an extrapolation of moisture content-relative vapour pressure, of differential heat of wetting-moisture data to zero evolved, or of external volumetric shrinkage moisture content data to zero shrinkage, or determining the shrinkage per unit specific gravity, the break in the logarithm of electrical conductivity-moisture content relation, or the break in the logarithm of a strength property-moisture content relationship.

The newer porous plate method, the nonsolvent water method and the non-freezing water method involve only a slight drying or none at all. Fibre saturation points of never-dried wood are appreciably higher than those of predried woods and vary only slightly with variation in the chemical composition of the wood substance. It is, however, substantially affected by extractives and ash content, especially when these are deposited within the cell walls, causing bulking and thus lowering the amount of water that can be held within the cell wall.

Excluded from the above methods is a method of measuring FSP using Hailwood-Horrobin sorption equation (1946) which involves the use of desiccators kept at 20C, where the relative humidity is controlled by various saturated salt solutions. Recently, this equation was applied by Yasuda and Minato (1992).

MATERIALS AND METHODS

Thirty samples, each 2 mm (T) x 25 mm (W) x 25 mm (L), were prepared from each of 30 identified OT timbers to ensure that the examined samples were at the exact EMC of the relative humidity in which they were kept.

Five desiccators filled with 5 different saturated salt solutions were prepared to provide five different relative humidity levels. These desiccators were kept at the controlled 20°C temperature. The relative humidity was monitored and recorded using a hygrometer inside each of the desiccators. Six of the 30 prepared samples from each of the OT timbers were conditioned into the prepared desiccators for 2 weeks. The desiccator set-up is shown in *Fig. 1.*

After two weeks, a few samples were selected and weighed repeatedly within two days at 6-h intervals to ensure the EMC was constant. The purpose of the pump was to avoid air condensation and to create a slightly vacuumed condition to enable the moisture sorption to reach the EMC in which they were kept. The salt solutions used to create various relative humidity levels,at 20°C are listed in Table 1.

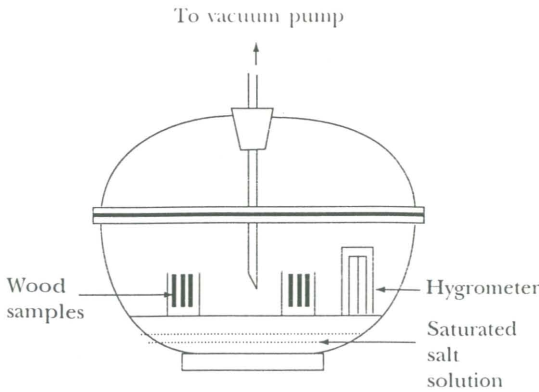

Fig. 1. Set-up of desiccator for fibre saturation point determination

TABLE 1
Types of salt used to create five levels of relative humidity

Salts Solutions	Molecular Formula	Relative Humidity (%)
Magnesium chloride	$MgCl_2 6H_20$	33
Sodium nitrite	$NaNO_3$	66
Sodium chloride	NaCl	76
Ammonium sulphate	$(NH_4)_2SO_4$	81
Potassium nitrite	KNO_3	93

The results obtained from the desiccation were simplified and calculated using Minitab (curvilinear regression) after Thomas (1982). The FSP values were calculated using the following formulas:

where H = relative humidity, M = moisture content, K_1 = equilibrium constant, K_2 = molecular weight of dry wood, Mh = hydrated water and Ms = dissolved water

$$H/M = A + BH + CH_2 \qquad (1)$$

where

$$A = \frac{W}{18K_2(K_1 + 1)} \qquad (2)$$

$$B = \frac{(K_1 - 1)W}{1800\ (K_1 + 1)} \qquad (3)$$

$$C = \frac{K_1 K_2 W}{180000\ (K_1 + 1)} \qquad (4)$$

$$K_1 = 1 + \frac{B^2 + B\ (B^2 + 4AC)^{1/2}}{2AC} \qquad (5)$$

$$K_2 = \frac{50[-B + (B^2 + 4AC)^{1/2}]}{A} \qquad (6)$$

$$W = 1800\ (B^2 + 4AC)^{1/2} \qquad (7)$$

$$Mh = \frac{1800\ K_1 K_2 H}{W(100 + K_1 K_2 H)} \qquad (8)$$

$$Ms = \frac{1800 K_2 H}{W(100 - K_2 H)} \qquad (9)$$

$$FSP(\%) = Mh + Ms \qquad (10)$$

RESULTS AND DISCUSSION

The FSP values of the OT timbers calculated to 100% relative humidity are tabulated in Table 2. The mean FSP (21%) of the OT timbers falls in the range of 17 - 33%. The assumption of FSP values made by many well-known authors which ranges between 25 - 30% (Frederick 1967) is smaller in range than the determined FSP value of OT timbers. This is due to the species variety and greater differences in magnitude of wood properties (Kollmann 1968).

Below FSP value, shrinkage and swelling take place; these are associated with changes in dimension, strength and other properties (Tsoumis 1968). Drying of any timbers below FSP needs extra energy to evaporate the moisture from the cell walls (Walker 1993). Therefore, at FSP a harsher drying condition is necessary to facilitate better drying.

Drying of timbers under harsher conditions above FSP could result in serious seasoning defects (Desch 1974). Two species with different FSP values will shrink at different rates. For example, species of Bawing will start to shrink at an FSP of 33%, whereas Magas starts to shrink at 17%. If harsher conditions are applied at the FSP of 33%, Magas will be dried rapidly, which could result in serious seasoning defects. Thus kiln dry operators should not mix timbers with great differences in FSP values in a single chamber during kilning of timbers.

TABLE 2
Fibre saturation point values of OT timbers of Sabah

Vernacular Name	Scientific Name	FSP (%)
Magas	*Duabanga* sp.	17.24
Rengas	*Melanorrhoea* sp.	17.35
Terap	*Parartocarpus* sp.	17.60
Ramin	*Gonystylus* sp.	17.74
Sendok-sendok	*Endospermum* sp.	17.77
Geronggang	*Cratoxylon* sp.	17.80
Laran	*Neolamarckia* sp.	17.99
Kedondong	*Canarium* sp.	18.20
Talisai	*Terminalia* sp.	18.22
Ipil	*Afzelia* sp.	18.23
Obah	*Syzygium* sp.	18.25
Bintangor	*Calophyllum* sp.	18.97
Kasai	*Pometia* sp.	19.34
Sepetir	*Sindora* sp.	19.45
Binuang	*Octameles* sp.	19.69
Pengiran	*Anisoptera* sp	19.72
Malulok	*Gordonia* sp.	19.80
Bangkulat	*Linoceira* sp.	19.84
Limpaga	*Azadirachta* sp.	20.04
Darah-darah	*Myristica* sp.	20.24
Sedaman	*Macaranga* sp.	20.28
Sengkuang	*Dracontomelon* sp.	20.92
Minyak Berok	*Xanthophyllum* sp.	21.05
Mempening	*Lithocarpus* sp.	22.26
Durian	*Durio* sp.	22.50
Ranggu	*Koordersiodendron* sp.	24.09
Bayor	*Pterospermum* sp.	27.54
Tembusu	*Fragraea* sp.	29.06
Karpus	*Hydnocarpus* sp.	31.25
Bawing	*Adinandra* sp.	33.33
N		29
Mean		20.73
Std. deviation		4.05
Min		17.24
Max		33.33

The FSP values of OT timbers can be tabulated into percentage ranges as shown in Table 3, which group the species with similar FSP values. In agreement with the theory that timbers shrink and swell at FSP (Walker 1993), the feasibility of this grouping or classification needs to be studied further to foresee the practical use of drying timbers of different species which have similar FSP values. This could help in the proper

TABLE 3
Classification of FSP values of the identified 'OT' timbers (range of 5%).

Fibre Saturation Point (%).			
15.00-19.95	20.00-24.95	25.00-29.95	30.00-34.95
Magas	Limpaga	Bayor	Karpus
Rengas	Darah-darah	Tembusu	Bawing
Terap	Sedaman		
Ramin	Sengkuang		
Sendok-sendok	Minyak Berok		
Geronggang	Mempening		
Laran	Durian		
Kedondong	Ranggu		
Talisai			
Ipil			
Obah			
Bintangor			
Kasai			
Sepetir			
Binuang			
Pengiran			
Malulok			
Bangkulat			

the feasibility of this grouping or classification needs to be studied further to foresee the practical use of drying timbers of different species which have similar FSP values. This could help in the proper utilization of timbers of varying species and occurrence. This could also probably be an economic way of drying timbers.

The FSP value is also an important indicator in the prevention of decay and insect attack (Kollmann 1968). Therefore, knowing the FSP values of these OT timbers the millers can be guided into controlling the timbers to reduce handling and storage costs.

CONCLUSION AND RECOMMENDATIONS

Thirty OT timbers were identified. Their basic densities range from 285 - 732 kg/m^3, and their FSP values range from 17 - 33%.

OT timbers consist of a broad range of species with differences in basic densities and FSP values. Attempts to utilize and manage these timbers need clear understanding of each and every species. Identification is necessary for proper utilization and management of these species. The density of OT timbers in relation to FSP should be extended into mill practices under kiln drying and other manufacturing processes.

OT timbers or lesser known timbers, which are assumed to be underutilized, are highly utilized by mills throughout Sabah. A study on their actual composition and processing needs to be carried out to enhance and improve the management of forests in Sabah, especially in an attempt to solve the problems of species heterogeneity, scattered occurrences of low availability species, size, and their market penetration. New training programmes for log and/or timber graders should be formulated by the Malaysian Timber Industry Board (MTIB) or the Forestry Department. This could help timber users to identify logs or timbers correctly to ensure accelerated promotion of these OT timbers in commercial activities.

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