International Journal of Science, Environment and Technology, Vol. 4, No 5, 2015, 1360 – 1364
ISSN 2278-3687 (O)
2277-663X (P)

EXPERIMENTAL MEASUREMENT OF THERMAL CONDUCTIVITY OF WOOD SPECIES IN INDIA: EFFECT OF DENSITY AND POROSITY

M. Vasubsbu[1]*, B. Nagaraju[2], J. Vijay Kumar[2], R. Jeevan Kumar[3]
[1]Dept of Applied Sciences, St. Ann's College of Engineering Technology, Chirala, India
[2]Dept of Physics, Sri Krishnadevaraya Engineering College, Sri Krishnadevaraya University, Anantapur, India
[3]Dept of Physics, Sri Krishnadevaraya University, Anantapur, India

Abstract: The paper reports experimental study of thermal conductivity of Indian woods of different species belonging to different botanical families by using Modified lee's apparatus. Thermal conductivity and porosity measured at normal dried condition. A significant variation in thermal conductivity, density and porosity is observed with respect to each species as well as same species of same botanical family. Macro and micro structured variations in wood have been analyzed on the basis of variation in above parameters.
Keywords: Indian woods, thermal conductivity, density, porosity, microstructure variation.

1. Introduction

Wood is a natural organic anisotropic composite material that consists of cellulosic fibers and lignin, use both as a solid fuel and as a construction material [13]. Because of the significant presence of wood and wood products in buildings, the energy design of wood frame buildings and the evaluation of their energy performance depend in part on thermal properties of wood products [3]. The analysis of combustion and pyrolysis of wood exposed to fire also demands the knowledge of thermal properties [2,6]. Thermal conductivity that represents quantitatively the ability of wood to conduct heat is of great significance in heat transfer modeling [7]. Measurement of thermal conductivity of wood dates back several decades [1].

Several researchers have developed various methods for the measurement thermal conductivity transient techniques, such as the laser flash method [4], transient plane source technique [5], and transient hot wire method [10]. Thermal conductivity of various soft and hard woods was measured for different moisture levels with density and temperature [5.8-9, 12]. Suleyman *Korkut* reports transverse thermal conductivity of wild cherry heat –treated using thermo wood method [14].

*Received Sep 6, 2015 * Published Oct 2, 2015 * www.ijset.net*

This article reports that thermal conductivity coefficient of different Indian woods belonging to different botanical families and compared with density and porosity.

2. Material and Methods

Twenty different wood logs are collected belonging to different botanical families from different places at normal dried condition for present investigation. The test samples were obtained from the sapwood region in the form of pellets, thermal conductivity was measured by modified lee's apparatus.

3. Results and Discussion

Heat exchange in living organism under natural conditions is one of the most important processes, where this process is under constant interaction with external environment. Thermo regulation in living organism can be with the process of heat transfer, can be understood by the study of thermal conductance of macro molecular, fluids and extracts present in different systems which carry out life process

Table 1 presents the data on the density, thermal conductivity and porosity of twenty Indian wood species taking 5 samples of each in normal dried condition. It is evident from the data the above parameters are varying from specimen to specimen belonging to same and different botanical families.

Thermal conductivity of hard woods (Mammee apple (MA): 5.25, ±0.42; Madhras thorn (MT): 4.2, ±0.33) is found to be more compared to soft woods (Sugar-apple (SA): 1.58, ±0.33; Curry Tree (K): 1.47, ±0.22; Rain tree (RT): 1.76, ±0.2)(Table1)

The variation in thermal conductivity in different woods of same and in different botanical families is due to the density variations and high thermal conductivity is attributed to low porosity. Wood is a good thermal insulator; its thermal conductivity values are low. The thermal conductivity of wood is affected by a number of basic factors: density, moisture content, extractive content, grain direction, structural irregularities such as checks and knots, fibril angle, and temperature. Thermal conductivity increases as density, moisture content, temperature, or extractive content of the wood increases and decreases with porosity.

Thermal conductivity and Porosity related to density, wood sample with high density shows high thermal conductivity. This may be attributed to the elongation of fiber and molecular architecture of the cell wall with its special chemical composition also here plays an important role. The variation of thermal conductivity of wood parallel to the grain depends upon the strength of the fibers and is affected not only by the nature and dimensions of the wood elements but also by their arrangement.

Thermal conductivity is a critical attribute when offering energy conserving building products; this is due to the fact that wood has excellent heat insulation properties. Lower thermal conductivity values equates to greater heat insulating properties [11].

4. Conclusions

1. Thermal conductivity coefficients of the twenty wood species of different botanical families were determined for tangential direction. The highest in thermal conductivity and lowest in porosity was recorded in Mammee apple (MA). This may attribute that low porous nature of wood reflects to combustion efficiency of wood.

2. Thermal conductivities values for the samples were found to confirm to the generarange of conductivity for wood materials. Thermal conductivity is regarded as the most important characteristic of a thermal insulator since it affects directly the resistance to transmission of heat that a material offers. The lower the thermal conductivity value, the lower the overall heat transfers.

References

[1] MacLean, J. D. 1941. Heat. Piping Air Cond.Vol.13(1941), pp.380–391.

[2] Ragland, K.W., D.J. Aerts, and A.J. Baker. Bioresour. Technol. Vol. 37(1991), pp.161–168.

[3] TenWolde, A., J. D. McNatt, and L. Krahn. Tennessee (1998). 40 pp.

[4] Harda. T,T. Hata, and S. Ishihara. 1998. J. Wood Sci. Vol.44 (1998), pp.425–431.

[5] Suleiman, B. M., J. Larfeldt, B. Leckner, and M. Gustavsson. Wood Sci. Technol.Vol. 33(1999), pp. 465–473.

[6] Thunman, H. and B. Leckner. Biomass Bioenergy.Vol 23(2002), pp. 47–54.

[7] Olek, W., J. Weres, and R. Guzenda..Holzforschung .Vol.57(2003),pp.317–325.

[8] Rice, R.W. and R. Shepard. Forest Prod. J.Vol. 54(2004),pp.92–94.

[9] Ngohe-Ekam, P.S., P. Meukam, G. Menguy, and P. Girard. Constr. Build. Mater. Vol.20 (2006), pp.929–938.

[10] Kol, H. Sx. Forest Prod. J. Vol.59 (2009), pp.58–63.

[11] Daniel DP INC 5 North Park Drive Hunt Valley, MD 21030, USA(2010), Pp. 1-5

[12] Zi-Tao Yu, Xu Xu, Li-Wu Fan,Ya-Cai Hu and Ke-Fa Cen.2011.Forest Products Journal Vol. 61, No. 2(2011),pp.130-135.

[13] Yacipi Faith, Ayhan Ozifici, Rasit Esen, Seref Kurt. Bioresourses Vol.6,No.3 (2011), pp.2757-2762.

[14] Suleyman Korkut, Ayhan Aytin, Çagatay Tasdemir, Lidia Guru. Proligno.vol.9, No.4 (2013) pp.679-683.

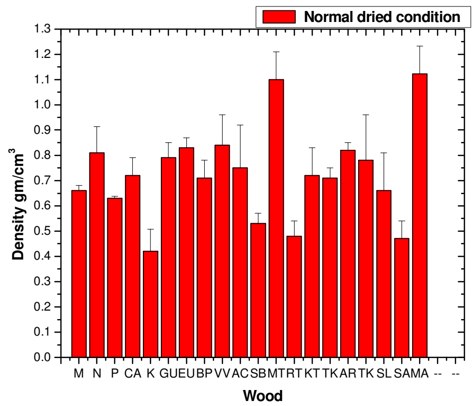

Fig 1. Variation of density of different woods.

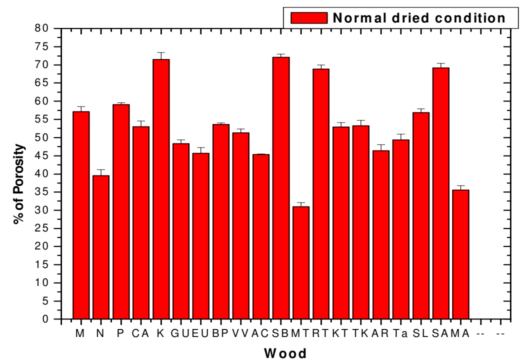

Fig 2. Variation of Percentage of porosity of different woods.

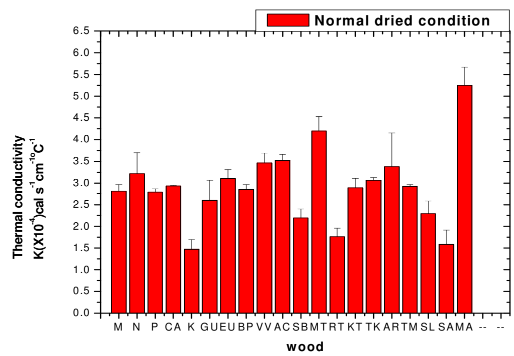

Fig 3. Variation of Thermal Conductivity of different woods.

Table 1: Data on thermal conductivity of different Indian woods

Common Name	Type of wood	Botanical Family	Density (gm/cm^3)	% of Porosity	Thermal Conductivity K(X10^{-4}cal s^{-1}cm^{-1o}C^{-1})
Mango(M)	Hard wood	Anacardiaceae	0.66±0.021	56.86±1.33	2.81±0.15
Neem(N)	Hard wood	Meliaceae	0.93±0.103	47.05±1.72	3.21±0.49
Peepal(P)	Hard wood	Moraceae	0.63±0.008	58.82±0.53	2.79±0.07
Casuarina(CA)	Hard wood	Casuarinaceae	0.72±0.07	52.94±1.56	2.93±0.01
Curry Tree(K)	Soft wood	Rutaceae	0.42±0.088	72.55±1.92	1.47±0.22
Guava(GU)	Hard wood	Myrtaceae	0.79±0.06	48.37±1.08	2.6±0.46
Eucalyptus(EU)	Hard wood	Myrtaceae	0.83±0.04	45.75±1.55	3.1±0.21
Black Plum(BP)	Hard wood	Myrtaceae	0.71±0.07	53.59±0.45	2.85±0.11
Velvet mestique(VV)	Hard wood	Mimosoideae	0.84±0.12	45.09±1.06	3.46±0.23
Acacia(AC)	Hard wood	Mimosoideae	0.75±0.17	50.98±0.18	3.52±0.14
Subabul(SB)	Soft wood	Mimosoideae	0.43±0.04	65.36±0.94	2.19±0.21
Madhras thorn(MT)	Hard wood	Mimosoideae	1.1±0.11	28.11±1.08	4.2±0.33
Raintree(RT)	Soft wood	Mimosoideae	0.48±0.06	68.63±1.15	1.76±0.2
Kadam (KD)	Hard wood	Rubiaceae	0.72±0.11	52.94±1.19	2.89±0.22
Teak (TK)	Hard wood	Lamiaceae	0.71±0.04	53.59±1.48	3.06±0.06
Arjun tree(AR)	Hard wood	Combretaceae	0.82±0.03	46.41±1.64	3.37±0.78
Tamarind tree(TM)	Hard wood	Fabaceae	0.78±0.18	49.02±1.63	2.92±0.036
Sal tree(SL)	Hard wood	Dipterocarpaceae	0.66±0.15	56.86±1.07	2.29±0.29
Sugar-apple(SA)	Soft wood	Annonaceae	0.47±0.07	69.28±1.27	1.58±0.33
Mammee apple(MA)	Hard wood	Sapotaceae	1.12±0.11	26.67±1.24	5.25±0.42