17th World Conference on Nondestructive Testing, 25-28 Oct 2008, Shanghai, China

Comparing sound absorption characteristic of acoustic boards made of Aspen particles and different percentage of Wheat and Barely straws

Mohammadali SAADATNIA [1] , Ghanbar EBRAHIMI [1] , Mehdi TAJVIDI [1]

**[1] Wood and Paper Industry Faculty of Natural Resources,
University of Tehran,
Chamran Street, PardiseKeshavarzi va Manabe Tabi, Grooh Oloom va Sanaye Choob va Kaghaz, Karaj, Iran, Tel: +982612249311, Fax:+982612249311
E-mail:m_saadatnia92@yahoo.com, ebrahimi@nrf.ut.ac.ir, mtajvidi@hotmail.come**

Abstract

In this investigation, the influences of two kinds of agricultural residues (Wheat and Barely straws) mixed with aspen particle were studied for use as insulation boards. the manufacturing parameters were: a kind of straw(Wheat and Barely straw), different percentage of straws(0/100, 10/90, 20/80 and 30/70 weight of straw/ aspen particles) of 0,10,20, and 30 wt% and specific gravity of 0.2,0.4 and 0.6 gr/cm³. A commercial urea-formaldehyde adhesive as used as binder. Sound absorption coefficients were measured at five frequencies (250, 500, 1000, 2000 and 4000 hertz).The results showed when frequencies increased, sound absorption increased until it reached to frequency of 2000 Hz but at 4000 Hz sound absorption coefficient decreased. Between manufacturing parameters, kind of straw didn't have significant influences on sound absorption coefficients. The best density for absorb sound waves under 1000 Hz was 0.4 gr/cm³ with 30% of straws. For waves with frequency higher than 1000 Hz the best density was 0.2gr/cm³ with 30% of straws.

Keywords: agricultural residues, Aspen, wheat and barely straws, sound absorption coefficient.

Introduction

Acoustic properties for absorb sound waves are so important in places such as conference halls, cinema, hospital and houses near streets and high ways. Fiber glass is the most fashionable material which used as insulation material (Liaghatii,1990) but environmental problems of these materials limit usage of them. Use of agricultural residues as insulation boards are developed over a wide of world (Yougquist,1994). Agricultural residues are used as raw materials for fabricating particleboards because of availability and low cost (Youngquist,1994).Composites fabricated with cotton fibers and with density of 0.6gr/cm³ showed good acoustic and thermal properties (Lawniezak, 1961). Rice-straw particleboards with density of 0.4 and 0.6gr/cm³ had high sound absorption coefficient (Hang-seung, 2003) and composite of rice straw and tire waste had the highest capacity of absorbing sound (Hang-seung, 2004). Because agricultural waste is in an absorbing material group, so studying about reaction of these materials for absorbing waves in different frequencies are inevitable.

2. Materials and methods

2.1 materials

Aspen particles with sizes between 1to4 cm were chosen. The agricultural lignocellulosic fibers used in this study were Wheat and Barely straws. Wheat and Barely straws harvested at the same time cut into small particles and after screening, sizes between 1to4 cm were chosen. Commercial UF resin was purchased from Samet Co in Mashhad.

2.2 Sample preparation

Straw-Aspen particle boards of 25*25*105 (cm) were manufactured at different specific gravities of 0.2, 0.4 and 0.6 gr/cm³ with Wheat and Barely straw contents of 0, 10, 20 and 30 (wt %).

The UF adhesive was mixed with particles and straws using a mixer for 15 min .The aluminum mold which equipped with stops was used to press mat .The press conditions for particleboards were 30kg/cm³ at 165 C for 6min. the final thickness of fabricated particleboards was 1.5 cm. The resultant boards were trimmed to avoid edge effects and then cut into disk with diameters of 3 and 10 cm to measure NRC%.

2.3Acoustical properties

To determine the acoustical property of the composites, the sound absorption coefficients were determined by the impedance tube method, ASTMC384-98 (American society for testing and materials, 1999). Each value represents the average of three samples. Impedance tube (model 4002) with variable diameter of 3 and l0 cm was used .for measuring NRC% under 1000Hz, disk with diameter of l0 cm was cut and for upper than 1000 Hz disk with diameter of 3 cm was cut.

3. Results and discussion

3.1 Effect of Kind of straw on noise reduction coefficient

Two kinds of straw (Wheat and Barely straw) were added to Aspen particles. In both of two kinds of straws when frequencies increased, noise reduction coefficient increased until it reached to 4000 Hz. Measured values showed no significant differences between Wheat and Barely straw in NRC%. These straws showed the same reaction against sound waves over a wide frequency range. Similarity between structure of Wheat and Barely straws showed the same result. (Fig.2)

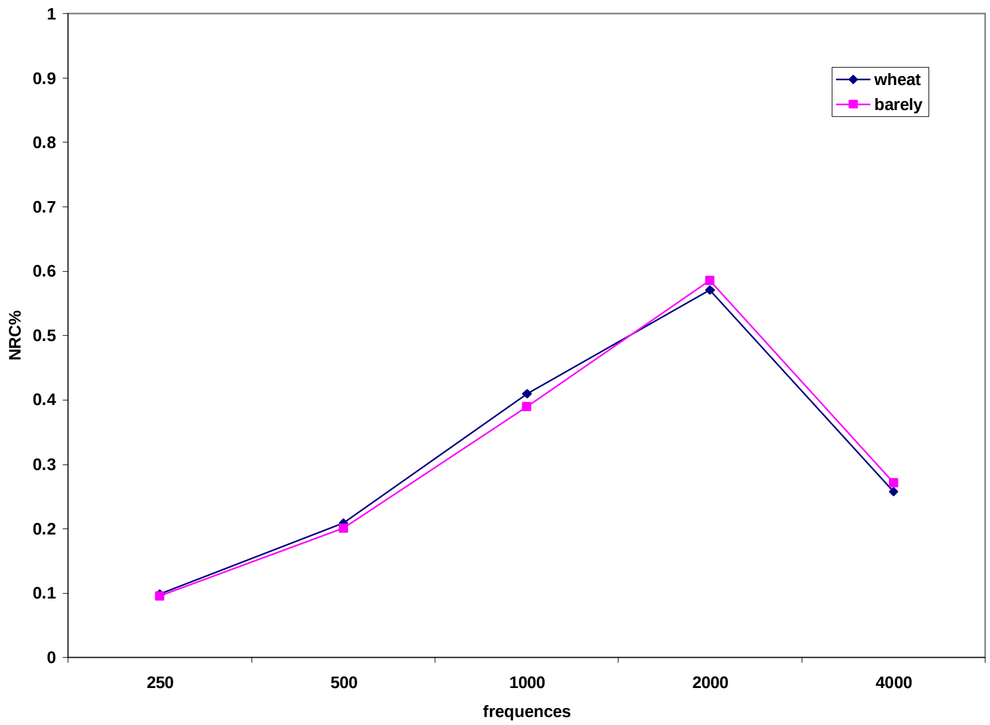

Fig1 Effect of two kinds of straw (Wheat and Barely straws) on NRC%
All of the points are in the same groups

3.2 Effect of different percentage of straw on NRC%

Results showed in low frequencies, the capability of straws and Aspen particles for absorbing sound waves were weak. For example at frequency of 250 Hz, straws and Aspen particle NRC% were less than 1%, in addition to, at frequency of 500 Hz Aspen particles had higher sound absorption coefficients than particles mixed with different percentage of straws, at frequency of 1000 Hz straws-Aspen composite had higher sound absorption coefficients than Aspen particle boards. So at given frequency the higher amount of NRC% was caused by straws added to composite. At frequency of 2000 Hz, both of materials, Aspen and straws showed the highest power for sound absorbing and the measured values were same. At frequency of 4000 Hz, there was reduction in NRC%. This reduction in given frequency contributed to the specific characteristic of straw-Aspen particleboards reflecting sound waves at high frequency(4000Hz) and absorbing sound waves under 4000 Hz. At 4000 Hz composite with 30% of straws had the highest noise reduction coefficient.

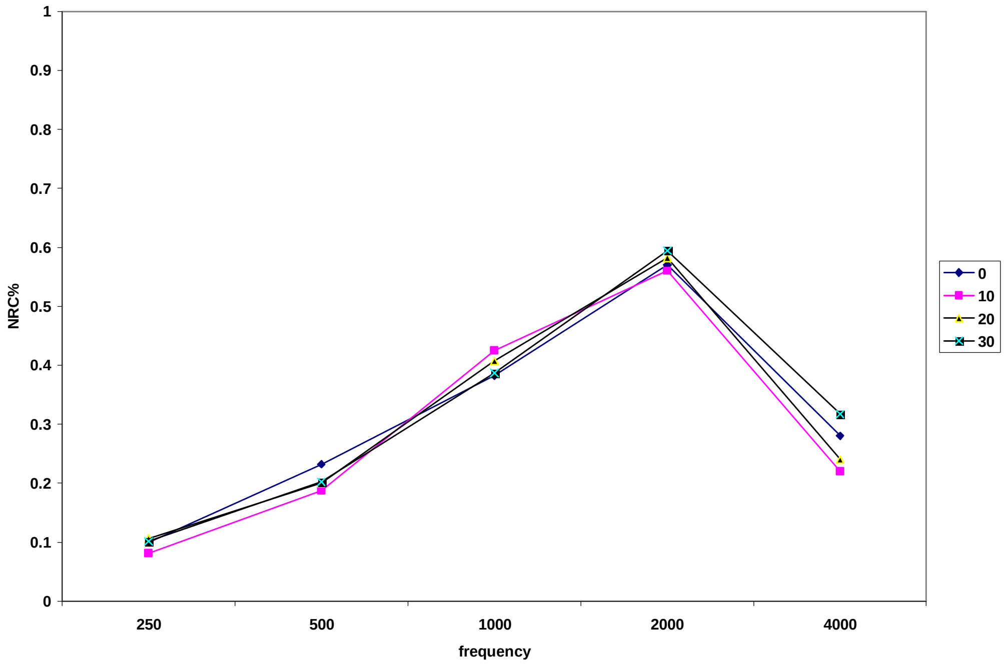

Fig2. The effect of different percentage of straws on NRC%

3.3 Effect of density on NRC%

Measured values showed for frequencies under1000 Hz, density of 0.4gr/cm³had the highest noise reduction coefficients (250, 500 and 1000Hz). For frequencies at 2000 and 4000Hz, density of 0.2gr/cm³ had the highest NRC%. These changes contributed to the opened structure of composite at low frequencies and low thickness but at high frequencies, free spaces in composite were the most important factor (fig3).

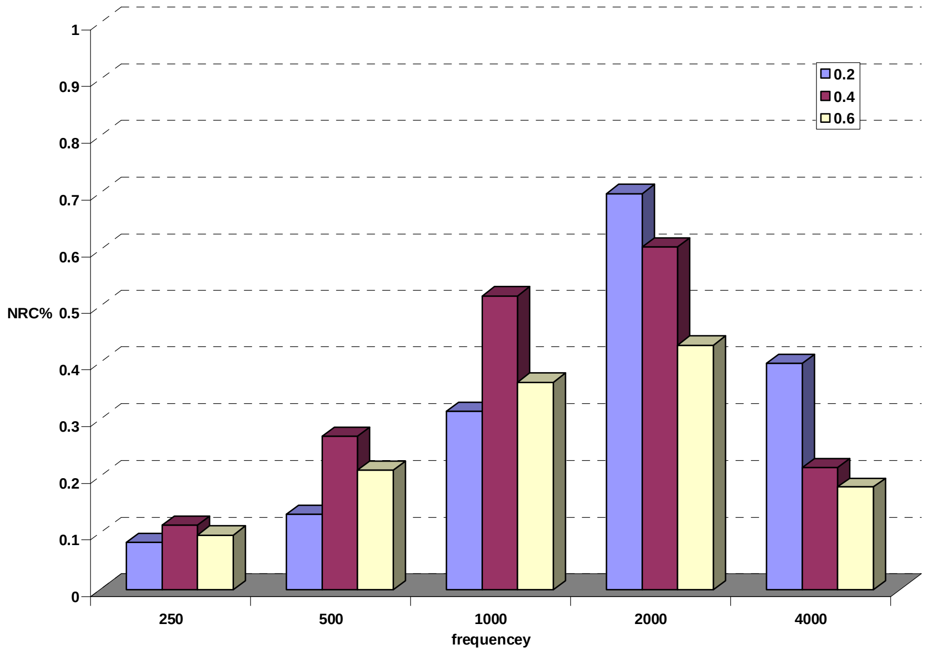

Fig3 At low frequency, density of 0.4gr/cm³ was superior but for frequency upper than 1000Hz, density of 0.2gr/cm³ had the highest NRC%.

3.4 The interaction effect of density and percentage of straw on NRC%

Under frequency of 1000 Hz, for composite with density of 0.4gr/cm³, when percentage of straw increased from 0 to 30%, NRC% increased 36%, 10% and 1% at 250Hz, 500Hz and 1000Hz respectively. For frequencies of 2000Hz and 4000Hz, for composite with density of 0.2gr/cm³, when percentage of straw increased from 0 to 30%, NRC% increased 28% and 13% respectively (table1).

Table1. Interaction effect of density and percentage of straw on NRC%

		Frequency				
density	straw%	250	500	1000	2000	4000
0.2	0				0.557	0.442
	30				0.783	0.492
0.4	0	0.096	0.29	0.488		
	30	0.151	0.322	0.497		

4. Conclusions

In all cases, when frequency increased, the sound absorption coefficients increased except at 4000 Hz. this increase and decrease was due to the specific characteristic of straws. There was no significant difference between two kinds of straw (Wheat and Barely straw) in absorbing sound waves. Different percentage of straw showed unclear effects on NRC%. In some frequency it increased NRC% but in another frequencies didn't have significant effect on NRC%. There was significant effect of interaction between density and percentage of straw on NRC%. In proper density, NRC% averagely increased 20% when percentage of straw increased.

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