RESEARCH ON SOME TECHNICAL FACTORS OF MANUFACTURING COMPOSITE FROM COIR FIBER AND WASTE TIRE CHIPS WITH UREA-FORMALDEHYDE RESIN AS A SUBSTRATE

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SUMMARY

The problem of using waste from the processing or reusing of waste materials has been established by many countries in the world for efficient utilization of resources and minimizing environmental pollution. Coconut coir fiber and Waste tire chips are two types of materials made from various natural and man-made scraps. However, by combining them with appropriate proportions, they will create a good substrate for the creation of composites as materials for the manufacture of furniture and building materials with the participation of substrate urea-formaldehyde (UF). This paper presents the results of research: Good bonding ability of the rubber specimens made from waste tires together with the adhesive of UF by hot press; and the correlation of temperature, compression time and amount of substrate to the quality of composite CCF and WTC. The results show that: Under the influence of technological factors: Temperature of 165^{o}C; Compression pressure 1.85 MPa; Pressing time of 2.5 min/mm thickness; Adhesive UF 15%; The raw material ratio of reinforcement (by product volume) of Coconut coir fibers/Waste tire chips : 75/25, we can produce the composite material with the main properties: Density 0.525 g/cm^3; Modulus of rupture 16.95 MPa; Internal bonding 0.67 MPa; Thickness swelling 1.16%. The physical-mechanical properties of composite Coconut coir fibers and Waste tire chips are higher than the requirements of common particleboard.

Keywords: Coconut coir fiber, coir fiber composite, urea-formaldehyde resin, waste tire chips.

1. INTRODUCTION

There have been billions of wasted tires worldwide that can no longer be used. Of which, there is only 7% had been mixed in order to make roadbed, barriers, walls and other purposes for population, other 7% is recycled to make swings in playgrounds… 11% directly discharged into waste and especially, 49% of those tires burned that leads to air, land and water pollutions. (http://www.tapchigiaothong.vn/bi-mat-cua-nhung-chiec-lop-oto-bo-di-d64871.html).

Nowadays, Vietnam as well as many countries in the world are facing difficulties solving pollutions caused by waste tires. Waste tires can not be used in transportation may still be high in elasticity, and take hundreds of years to thoroughly decay in nature. Therefore, it may be a potential source of pollution. Research on how used tires can be turned into manufacturing will bring the good to the economy and significant benefit to the society as it will surely reduce pollution.

Tires generally and motorcyle tires particularly themselves are one type of composite material. When no longer functional, they get slide cut into certain sized parts which suit to the mixture with botanical fiber materials like coir fiber as a reinforce in the technology for composite materials with outstanding functions. For example: *Nguyen Minh Hung and Le Xuan Phuong (2015)* studied the possibility of using waste tyre to produce composite using PF adhesive, in this study, composite of mixture between waste tyre and rubber chips (ratio of 50 – 50) density 1.00 g/cm^3 has MOR 22.4 MPa, TS 2.54%; *Chizoba Obele, Edith Ishidi (2015)* studied the production of helmet when changing the ratio of coir fiber in composite with epoxy substrate. The results show that: composite material made with 30% coir fiber gave the highest impact strength 26.43 N/mm^2; *Nguyen Minh Hung and Hoang Viet (2016)* studied on the technological parameters to create composite from coir fiber and substrate urea-formaldehyde with the main properties: Density 0.76 g/cm^3, MOR 14.0 MPa, IB 0.35 MPa, TS 12%.

For indicating the possibility to creating composites containing reinforce from waste of the combination process between Coconut coir fibers and waste tire chips, we execute *'Research on some technical factors of manufacturing composite from coir fiber and waste tire chips using Urea-formaldehyde adhesive as a substrate'*.

2. MATERIALS AND METHODS

2.1. Materials

2.1.1. Coconut coir fiber

Coconut - Coos nucifera - is one of the Coconut species cultivated widely in Ben Tre (Vietnam). Dried Coconut fruit is the material mainly for Coconut copra products and all the other parts are used for side products including coir fiber.

Coconut coir fiber (CCF) made from Coconut processing facilities Ben Tre province.

Coir fibre is 100% natural and originates in the outer husk of Coconuts – it comes from part of the seedpod of the Coconut palm. To process coir, Coconuts are split so that the stiff fibres are accessible. CCF has 2 types: long Coconut coir fiber and short Coconut coir fiber. Most products from coir fiber are from short Coconut fiber. In this research, short Coconut coir fiber are used. (Figure 1 - http://textilelearner.blogspot.com/2015/06/an-overview-of-Coconut-coir-fiber.html).

Figure 1. Dried Coconut husks and short Coconut coir fiber

Form of coir fiber: after outer husk of Coconuts the major part of coir fiber of 20 cm, coir fiber is round sharped and has 3 diameter groups with different mechanical properties and volumes: i) group with the smallest diameters (d_1 = 0.15 mm) lies outer, accounting for 10 - 15% of the total weight of fibrous husk; ii) group with average diameters (d_2 = 0.37 mm) making up for 60 - 70%; iii) lies inner the group with largest diameters (d_3 = 0.59 mm) making up for 15 - 20%, this group is close to shell Coconut so a small amount of fiber is pressed to a pressed round section. Those deformed are not common and stick to shell Coconut (Hoang Xuan Nien, 2004).

Some major physical, mechanical and chemical properties (Table 1).

The length of fiber is around 20 cm, average diameter differential among each group is d = 0.22 mm.

Moisture absorption of Coconut coir fiber is low its humidity is 8.2%, in a moistured and saturated medium. This property indicates: coir fiber is advantageous for drying and preservation (Slare F.O., 1976).

Tensile strength of the group with smallest diameters is the highest, followed by the one with average diameters' figure at 46% as high, the figure for the group with largest diameters is 48% as high as that for the group of average diameters (Almeida. J.R.M.D. et al. 2008).

Chemical components of CCF: Cellulose 38.9%; Lignin 32.5%; Pentozan 23.5%; Refractive index: Dissolved in solution NaOH (1%) 18.9%; Hot water 3.7%; Cold water 3.1%; Alcohol 2.7%; Ash 1.67%; Lipid 2.6%; and pH 6.28.

Table 1. Main properties of Coconut coir fiber

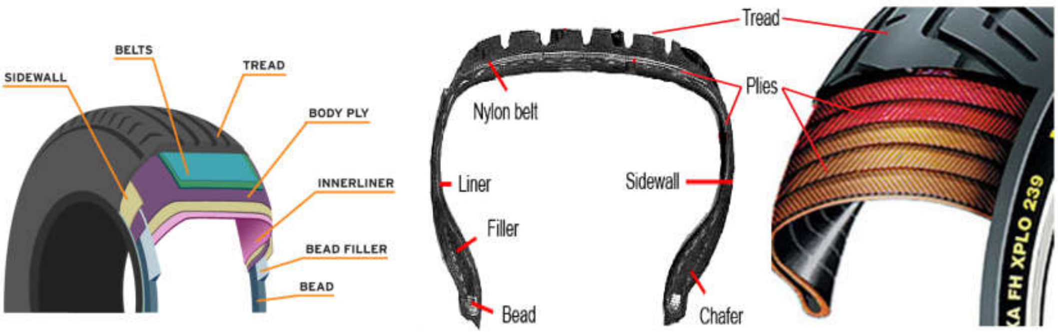
Main Properties of CCF	Average diameter (mm)		
	0.15	0.37	0.59
Density (g/cm^3)	0.41	0.363	0.455
Tensile strength (N/m^2)	1550.10^5	715.10^5	341.10^5
Cellulose, %		38.9	
Lignin, %		32.5	
Pentozan, %		23.5	
Ash, %		1.7	

Source: Hoang Xuan Nien, 2004.

2.1.2. Waste Tire Chips

Tires' structure: Various forms and sizes for different vehicles, however, tires have 2 common types: Tube tyre and tubeless tyre, both types have similar structure of: tread, plies, innierliner and bead as shown in figure 2.

Structured so, tires themselves are composite materials. After being used, tread block (tread area) wears out. Inner layers barely get affected. The piece of material used for creating rubber fibre is the inside layer of a waste tire (https://www.milestartires.com/tires-101/tire-construction).



(a) Tyre of car **(b) Tyre of motorcycle**

Figure 2. Tires' structure

(https://www.rideapart.com/articles/245511/everything-you-wanted-to-know-about-motorcycle)

According to Le Hong Tien (2006), the substantial composition of the tire according to weight includes: Natural rubber 38 - 40%; SBR (Styren Butadien) 30%; Butadien 19 - 20%; Butyl and Butylhalogenate 10%; Synthetic fibers (nylon, rayon and aramyt) for reinforcement 4%, metal wire (steel high in Carbon) 12%; and Oxit Silic 26%. Moreover, to strengthen necessary properties for the tire, some other metals are added to the structure such as Zn, Fe and Ca.

Physical properties of the tire used in research: Volume expansion factor 656.10^{-4} dm^3/^{o}C; Thermal conductivity 0.14 w/m°K (the same as wood 0.13 – 0.18 w/m^{o}K); Water and Moisture absorption of WTC are zero (Tran Thi Thuy Hoa, 2011).

2.1.3. Substrate

Substrate using in this study is urea-formaldehyde (UF) resin provided by Chensin - Taiwan Branch in Vietnam. The properties of urea-formaldehyde (UF) adhesive: Solid content 50 ± 1%; Density 1.20 g/cm^3; Viscosity 150 - 200 mPa.s (25^{o}C); pH 8.4.

2.2. Research method

2.2.1. Plan of single factorial experiment

Plan of single factorial experiment was used to research the effects of individual factors: time, temperature which effect to the bonding quality of the coir fiber composite product.

*2.2.2. **Plan of multi-factorial experiment***

Plan of multi-factorial experiment was used to research the effects of pressure, pressing time and the amount of substrate to certain physical and mechanical properties of coir fiber composite

- Income properties

+ Fixed properties: Density, thickness of composite, press pressure and the amount of substrate.

+ Flexible properties: Pressing temperature, pressing time.

- Outcome properties:

Mechanical and physical properties were tested according to test standard methods of Vietnam are: Modulus of rupture (MOR) – TCVN 7756-6: 2007, Tensile strength perpendicular to the surface (to determine internal bond durability - IB) – TCVN 7756-7: 2007, Thickness swelling (TS) – TCVN 7756-5: 2007.

- The main equipments used in this study were: Climate chamber Jeiotech TH-G180L; Universal testing Mechanical MTS Qtest/25; the tools used: Digital Caliper Mitutoyo 0.001 mm; Balance Satorius BL 210.

- Working on statistics with statistic analysis Stagrafic 7.0 & Excel softwares.

3. RESULTS AND DISCUSSION

3.1. Indicating technical factors in the making of composites

Since WTC do not contain cellulose, hemicellulose and lignin which are main compositions of botanical material and are high in bond properties with synthetic resin. Therefore, we have to determine bond properties of waste tires using UF.

In this research, WTC were made by using waste tires after the two steel tire beads were separated and the other components were metal and any existing metals in the tires. The rest of the compositions generally remain. The cutting those tires to create fibers for composite making will be handcrafted.

3.1.1. Waste tire chips

Waste tire chips in this research was used for dimension (50L x 4W x 2T) mm

Processing WTC:

The length of chips: cut tires to as small as 50mm long.

The width of chips: original thickness of waste tires (4 mm).

The thickness of chips: continue cutting the pieces to smaller as 2mm, equal length to 50mm. Their general form is cube shaped, four-cornered cross section, they are calculated as WTC with rectangle sections.

Figure 3. Waste Tire Chips

Density of WTC: materials' density affects significantly technical factors and properties of products. Therefore, testing the density of tires is needed to calculate participating factors in the process.

Density of WTC is determined as follows: Pick any 3 tires: cut them into 6 specialized slices 50 mm, 6 points of each slice position equidistantly to each other by the perimeter of the tire. Take 3 specimens (50 x 50) from each slice to test the density of tires. The first specimen in the center of slice, the 2nd and 3rd are 1.5cm to the edge.

Density of WTC determined in accordance with TCVN 7756-4: 2007 is $\gamma = 0.926$ g/cm^3 (Nguyen Minh Hung and Le Xuan Phuong, 2015).

Compared to natural rubber's density ($\gamma_{cstn} = 0.913$ g/cm^3), density of WTC used in research is higher.

3.1.2. Bond properties of rubber chips from waste tires with UF resin

Since the features of rubber fibers from handcrafted waste tires are curved, curled, rectangle or lozenge (different sides) (2x4) mm section (Figure 3). Within the section, there are 3 forms of surfaces: Outside (completely rubber); Inner (rubber coater fabric; Diagonal tires (cap plies) figure 4.

Considering the ability of rubber to stick together with another type of adhesive, the cross section of the WTC includes the ability to stick the two forms of contact surface left. In fact, there is no specific standard for testing the adhesion of rubber chips of waste tires, so the preparation of the test specimen and our method of testing are based on the standard of tensile strength perpendicular of the particle board for the experiment (TCVN 7756-1: 2007; 7756-7: 2007). The test of adhesion of waste rubber tires in accordance with this standard applies to three types of surface contact: the outer surface with the outer surface, Inner side with inner surface, and outer surface with inner surface. Not applicable to cross-sectional form of tires because of too small cross-sectional dimension (maximum 4 mm tire thickness) (Figure 3).

(a) Outer ***(b) Inner*** ***(c) Cross***

Figure 4. Sections of Waste Tires

Experiment to determine the adhesive ability of the tire rubber with UF resin:

a) Parameters of technology based on particleboard particle technology when using adhesive is UF resin. Details in figure 5.

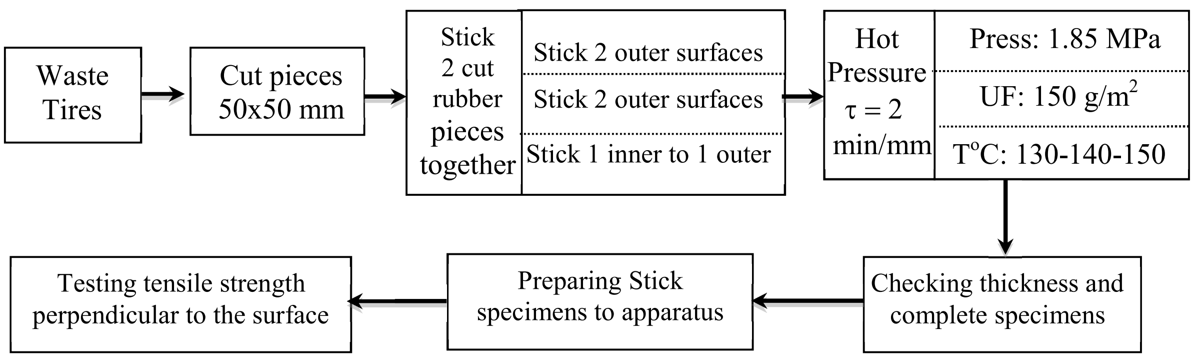


Figure 5. Chart of experiment to Tensile strength perpendicular to the surface

b) Experiment process (Figure 5):

- Cut waste tires into specific squares (50 x 50) mm.
- Stick 2 cut rubber pieces together in 3 samples order: Sample 1, stick 2 outer surfaces together; Sample 2, stick 2 inner surfaces together; Sample 3, stick 1 inner to 1 outer surface
- Hot pressing in 2 minutes/mm thick: Pressure 1.85 MPa, UF resin 150 g/m^2; Changes from 130, 140, 150^{o}C.
- Checking thickness: Redution in thickness when pressed is 12.42%.
- Prepare samples, tag them to testing apparatus to test tensile strength perpendicular to the surface (internal bond durability - IB).
- Number of Test samples by TCVN 7756-7: 2007: The 18 specimens/seri experiments; Repeatability of the experiment is 3. Results of specimens tested shown in table 2.

Table 2. Result of Testing bonding ability of Waste Tires
(Using UF resin)

Sample	Tensile strength perpendicular to the surface (MPa)		
	130^{o}C	140^{o}C	150^{o}C
Sample 1: stick 2 outer surfaces together	0.276	0.288	0.329
Sample 2, stick 2 inner surfaces together	0.337	0.339	0.383
Sample 3, stick 1 inner to 1 outer surface	0.283	0.291	0.361
Average Value	**0.299**	**0.308**	**0.358**

The tensile strength perpendicular to the surface – IB, internal bond durability - of all samples tested is proven up to standard TCVN 7756-7: 2007. Of which, sample 1 (2 outer surfaces together) has the smallest value of internal bond durability, followed by the higher figure for sample 2 (2 inner surfaces together), sample 3 has the highest internal bond durability. This is explained as follows. Sample 1 has the stuck area to be thorough the surface, though actually the pressed area includes the area of treads the outside surface of tires. Those treads do not match, hence, the stuck area is smaller than the pressed area. Sample 3 with inner and outer surfaces stuck together has higher pressed area than that of sample 1 as the stuck area include all treads. Sample 2 has 2 inner surfaces stuck to each other so the pressed area is the highest.

Comparing the results of testing internal bonding of samples in table 2 indicates: the only condition 150^{o}C hot pressing has the average internal bond to board surface durability (0.358 MPa) higher than the standard figure TCVN 7756-7: 2007 (0.35 MPa).

The results indicate that: Rubber chips from waste tyre can use UF resins as adhesive substance in the technology of creating material with pressing condition: UF resin 150 g/m^2; pressing pressure 1.85 MPa; pressing temperature 150^{o}C; pressing time 2 min/mm thickness.

3.2. Study technology condition of creating composites from CCF and WTC with UF resin as a substrate

a) Select the ratio between CCF and WTC (according to the density of boards)

- Dimensions of composite in experiment: Length x Width x Thickness : 40 x 40 x 1.6 cm (sample's volume is 2560 cm^3)
- The average dimensions calculated and actual indication of 54 fibers are: 46.53L x 1.94W x 3.67T (mm) (Nguyen Minh Hung and Le Xuan Phuong, 2015).
- Components' ratio (according to composite's density) of reinforce CCF/WTC respectively: 25/75; 50/50; 75/25

Calculating the amount of CCF and WTC in the experiment's results:

- Density of composite sample using mixture substrate between CCF and WCT is calculated by formation of Nguyen Hoa Thinh (2002):

$$\gamma = \gamma_1 p_1 + \gamma_2 p_2 + \ldots + \gamma_n p_n$$

Where:

γ is densitty of composite with mixture substrate;

$\gamma_1, \gamma_2 \ldots$ are densities of partner substrates in stucture of composite;

$p_1, p_2 \ldots$ are ratio of partner substrates in stucture of composite.

The density of WTC being 0.926 g/cm^3 (section 3.1.1); the density of CCF in the mixture of 3 different diameters according to natural ratio (section 2.1.1) being calculated to be 0.384 g/cm^3, we are able to measure the density of composite materials containing mixture of CCF and WTC in 3 ratio 25/75; 50/50; 75/25 and the mass of each reinforce material in table 3.

Table 3. Results of the calcular mass of each reinforce material and composite density

CCF/WTC Ratio	Density of composite (g/cm^3)	Mass (gam)		
		Composite	CCF	WTC
Ratio I: 25/75	0.797	2040.32	245.76	1793.66
Ratio II: 50/50	0. 659	1678.04	491.52	1195.77
Ratio III: 75/25	0.522	1333.32	737.28	597.89

b) Create sample composites

- The amount of reinforce material: according to mixture ratio (Table 3)
- The amount of UF resin: 15%
- Pressing pressure: 18.5 KG/cm^2
- Pressing temperature: 150^{o}C
- Pressing time: 2 min/mm thick
- Number of samples: 9 per experiment series

Results of the process of pressing to create composites:

Samples have mixture ratio as shown in figure 6.

Appearance: When the ratio CCF/WTC is 25/75, the composite board has WTC (black) displayed in the surface, which is displeasing. When the ratio goes up to 50/50 and 75/25, the surface is covered with a good amount of CCF, composite boards look more aesthetic. The boards with the ratio of 75/25 CCF covering the surface, CCF are all in the inside of the material (Figure 6).

(a) Ratio 25/75 **(b) Ratio 50/50** **(c) Ratio 75/25**

Figure 6. Composite samples with different ratio of CCF/WTC

When testing the MOR of samples according to TCVN 7756-7 standard and processing statistics by Excel, we determine the average MOR of reinforce composite mixture. Based on that, MOR result of sample with 25/75 ratio is the lowest (MOR_I= 9.97 MPa), followed by that of 50/50 (MOR_{II}= 15.54 MPa) and the highest figure is of the one with 75/25 (MOR_{III}= 16.80 MPa)

Compared to TCVN 7756-7: 2007 and the requirement for mechanical durability of particle board used for furniture and construction, the MOR must be at least 16.00 MPa.

Hence, we choose the mixture ratio of

CCF/WTC to be 75/25 to research technical statistics creating composites. (the ratio 25/75 does not meet requirements for appearance and MOR; the ratio 50/50 does not meet the requirement of MOR).

- Select research technical parameters: temperature (x1) to create materials, pressing maintaining period to create materials (x2). Table 4 & 5 are the change levels of researched statistics and plan of Two-factorial experriment. Statistics tested are: MOR, IB, ratio of thickness swelling of samples (TS).

Table 4. Change level of technical parameters

Parameters	Notation	Unit	Change level				
			– α	– 1	0	+ 1	+α
Press. temperature	X1	^oC	130	130	150	170	170
Press. Time	X_2	min/mm	1.0	1.0	2.0	3.0	3.0

Table 5. Plan of Two-factorial experiment

Number Exp.	x_1	x_2	X_1 (^oC)	X_2 (minute)
1	1	1	170	3
2	1	-1	170	1
3	-1	1	130	3
4	-1	-1	130	1
5	0	0	150	2
6	1	0	170	2
7	-1	0	130	2
8	0	1	150	3
9	0	-1	150	1

- The experimental results of Thickness Swell of composite:

Table 6 shows TS statistics of composite samples with CCF and WTC mixture as reinforce changing according to temperature and pressing time.

Table 6. The experimental results of Thickness Swell of composite

No. Exp.	X_1 (^oC)	X_2 (min/mm)	Y_1 - Thickness Swell (%)			
			Average Value	*1*	*2*	*3*
1	170	3	**1.15**	1.13	1.15	1.17
2	170	1	**1.20**	1.19	1.21	1.19
3	130	3	**1.64**	1.64	1.67	1.61
4	130	1	**1.88**	1.83	1.87	1.93
5	150	2	**1.18**	1.21	1.17	1.15
6	170	2	**1.16**	1.15	1.14	1.18
7	130	2	**1.75**	1.71	1.79	1.74
8	150	3	**1.20**	1.09	1.11	1.13
9	150	1	**1.28**	1.31	1.27	1.25

Processing statistics by Stagrific 7.0 & Excel softwares, results indicated are:

+ Code form of correlative equation:

$$y_1= 0.2011-0.2933*x_1-0.0616*x_2+ +0.0475*x_1*x_2+ 0.2433*x_1*x_1$$

+ Real form of correlative equation:

$$Y_{TS} = 16.924-0.2019*X_1-0.4179*X_2 + +0.0024*X_1*X_2+0.0006*X_1^2$$

Performance results:

$Y_{TS} = 1.09$ (%);

Temperature X_1: 160 (^oC);

Time X_2: 2.5 (min/mm).

- The experimental results of Internal Bond of composite:

Table 7 shows IB statistics of composite samples with CCF and WTC mixture as reinforce changing according to temperature and pressing time.

Table 7. The experimental results of Internal Bond of composite

No. Exp.	X_1 (^oC)	X_2 (min/mm)	Y_2 - Internal Bond (MPa)			
			Average Value	1	2	3
1	170	3	**0.73**	0.73	0.70	0.76
2	170	1	**0.62**	0.66	0.58	0.62
3	130	3	**0.59**	0.59	0.58	0.60
4	130	1	**0.44**	0.31	0.31	0.31
5	150	2	**0.54**	0.52	0.54	0.56
6	170	2	**0.72**	0.71	0.72	0.73
7	130	2	**0.58**	0.54	0.61	0.59
8	150	3	**0.48**	0.48	0.50	0.46
9	150	1	**0.34**	0.34	0.33	0.35

Processing statistics by Stagrific 7.0 & Excel softwares, results indicated are:

+ Code form of correlative equation:

$$y_2 = 0.506+0.076*x_1+0.066*x_2+0.16*x_1*x_1- -0.08*x_2*x_2$$

+ Real form of correlative equation:

$$Y_{IB} = 8.478-0.116*X_1+0.386*X_2+0.0004*X_1^2- -0.08*X_2^2$$

Performance results: Y_{IB} = 0.76 MPa;

Temperature X_1: 170 (^oC);

Time X_2: 2.4 (min/mm).

- The experimental results of Modulus of Rupture of composite:

Table 8 shows MOR statistics of composite samples with CCF and WTC mixture as reinforce changing according to temperature and pressing time.

Table 8. The experimental results of Modulus of Rupture of composite

No. Exp.	X_1 (^oC)	X_2 (min/mm)	Y_3 - Modulus of Rupture (MPa)			
			Average Value	1	2	3
1	170	3	**17.89**	17.28	18.32	18.08
2	170	1	**16.26**	15.68	16.27	16.82
3	130	3	**16.97**	16.20	17.11	17.60
4	130	1	**13.23**	13.20	13.50	13.00
5	150	2	**13.64**	13.64	13.63	13.65
6	170	2	**16.66**	16.85	16.21	16.93
7	130	2	**14.53**	14.50	14.10	15.00
8	150	3	**15.97**	16.30	15.70	15.90
9	150	1	**13.20**	13.10	13.20	13.30

Processing statistics by Stagrific 7.0 & Excel softwares, results indicated are:

+ Code form of correlative equation:

$$y_3 = 13.841+1.013*x_1+1.356*x_2- -0.527*x_1*x_2+1.653*x_1*x_1+0.643*x_2*x_2$$

+ Real form of correlative equation:

$$Y_{MOR} = 91.188-1.136*X_1+2.739*X_2- -0.0264*X_1*X_2+0.041*X_1^2+0.6433*X_2^2$$

Performance results:

Y_{MOR} = 17.98 MPa;

Temperature X_1: 170 (°C);

Time X_2: 3.0 (min/mm).

From the experimental results to determine the optimal technological parameters of the quality parameters (TS, IB, MOR), based on the existing facilities and experimental equipment, the most suitable technical parameters of composite materials are as follows:

- Composite of CCF and WTC with UF resin as a substrate:

+ Dimentions of experiment board: 50 x 50 x 1.8 cm;

+ Density: 0.522 g/cm^3;

+ Reinforce material: Ratio CCF/WTC : 75/25, Weight (CCF + WTC): 2348 g,

Where: CCF 1296 g (Short and nature);

WTC 1052 g, Size: (1.9 – 2) x (45 – 50) x (3.5 – 4) mm.

+ Substrate: Weight 15% UF resin;

+ Pressing Temperature: 165°C;

+ Pressing Time (retain max pressure): 2.5 (min/mm);

+ Press Pressure: 1.85 MPa.

- Testing results of the quality of composite materials according to standard TCVN 7756-(4÷7): 2007 are: Density 0.525 g/cm^3; TS 1.16%; IB 0.67 MPa; MOR 16.95 MPa.

All three physical-mechanical properties of composite Coconut coir fiber and Waste tire chips with substrate urea-formaldehyde are higher than the minimum quality of particleboard quality used as raw materials for furniture and construction (TCVN 7756: 2007).

Compared with the study results by Nguyen Minh Hung and Hoang Viet (2016), a composite made of coir fiber with a UF substrate ratio of 12.7% with a density of 0.76 g/cm^3, MOR 140 KG/cm^2, IB 3.5 KG/cm^2, the strengths of two types of materials (composite coir fiber and composite CCF with WTC) are equivalent. It also reinforces the notion that CCF combined with WTC can make a good reinforce mixture to produce composite with UF resin as a substrate.

However, comparing with the results of research by Nguyen Minh Hung and Le Xuan Phuong (2015) on composite from chips of *Hevea brasiliensis* wood (rubber wood) and Waste tire chips, the quality criteria of MOR composite this study was lower (16.95 vs 22.4 MPa) and TS was higher (1.16 vs 2.54%). The reason for the MOR quality index of this study is lower is because the density of composite is lower (0.525 vs. 1.00 g/cm^3), the ratio of WTC in 1 unit of volume (25 compared with 50%), UF substrate has less strength than PF adhesive; The TS composite quality index of CCF and WTC is better than that of composite mixture with rubber wood chips and WTC (1.16 vs 2.54%) because of the water absorption and moisture absorption of Coconut fiber lower than rubber wood chips.

4. CONCLUSIONS

1. Waste tire chips can be bonding together using urea-formaldehyde adhesive under the pressure of 18.5 KG/cm^2, pressing temperature of 150°C, the pressure retention time is 2.0 min/mm.

2. The Modulus of Rupture of the composite is increased by the amount of Coconut coir fiber in the range (ratio of CCF/WTC) from 25/75 to 75/25.

3. Under the influence of technological factors: Temperature 165°C; Compression pressure 1.85 MPa; Time to retain max press 2.5 min/mm thick; Adhesive UF 15%; The raw material ratio of reinforcement (by product volume) of CCF/WTC: 75/25, we can produce the composite material having the main properties: Density 0.525 g/cm^3; Modulus of rupture 16.95 MPa; Tensile strength perpendicular to the surface (IB) 0.67 MPa; Thickness swelling 1.16%.

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NGHIÊN CỨU MỘT SỐ YẾU TỐ CÔNG NGHỆ SẢN XUẤT COMPOSITE TỪ SỢI XƠ DỪA VÀ SỢI CAO SU LỐP XE PHẾ THẢI VỚI CHẤT NỀN LÀ KEO UREA-FORMALDEHYDE

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TÓM TẮT

Vấn đề sử dụng phế thải của các quá trình chế biến hoặc tái sử dụng các vật liệu phế thải đã và đang được nhiều nước trên thế giới đặt ra nhằm sử dụng hiệu quả tài nguyên và giảm thiểu ô nhiễm môi trường. Sợi xơ dừa và sợi cao su từ lốp xe là hai loại vật liệu được tạo ra từ các phế liệu có nguồn gốc từ tự nhiên và nhân tạo khác nhau. Nhưng, nếu biết kết hợp chúng với tỷ lệ thích hợp thì chúng sẽ tạo nên một cốt liệu tốt cho quá trình tạo ra vật liệu composite làm nguyên liệu cho quá trình sản xuất đồ mộc và vật liệu xây dựng với sự tham gia của chất nền phổ thông là keo urea-formaldehyde (UF). Bài báo trình bày kết quả nghiên cứu: Khả năng kết dính tốt của các miếng cao su lốp xe phế thải với nhau bằng chất kết dính của keo UF trong điều kiện ép nhiệt; và sự tương quan của nhiệt độ và thời gian ép tới chỉ tiêu chất lượng composite từ sợi xơ dừa kết hợp sợi cao su. Kết quả nghiên cứu đã chỉ ra rằng: Dưới tác động của các yếu tố công nghệ: Nhiệt độ 165^{o}C; Áp lực ép tạo vật liệu 1,85 MPa; Thời gian duy trì chế độ ép 2,5 phút/mm; Lượng chất nền keo UF 15%; Tỷ lệ cốt liệu (theo thể tích sản phẩm) sợi xơ dừa rối/sợi cao su lốp xe phế liệu là 75/25, ta sẽ tạo được vật liệu composite có tính chất chủ yếu: Khối lượng thể tích 0,525 g/cm^3; Độ bền uốn tĩnh 16,95 MPa; Độ bền kéo vuông góc 0,67 MPa; Tỷ lệ trương nở chiều dày 1,16%. Các chỉ tiêu về tính chất cơ lý đó của vật liệu composite sợi xơ dừa rối và sợi cao su đều cao hơn yêu cầu của ván dăm thông dụng.

Từ khóa: Composite xơ dừa, sợi cao su lốp xe phế thải, sợi xơ dừa, UF.

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