

DIMENSIONAL STABILITY ANALYSIS: WOOD-PLASTIC COMPOSITES

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The objective of this study was to analyze the use of wood flour in combination with recycled polymer in different proportions in the manufacture of body-of-proof with the composite-plastic timber for ASTM testing. Were subsequently injected the samples for the analysis of dimensional stability tests on thickness swelling and water absorption. The results show that the composites with higher percentage of wood flour to absorb more water because the wood fibers, but have less degree of water absorption and thickness swelling that conventional wood and can therefore replace it in some cases and still contribute to recycling and preserving the environment.

Palavras-chaves: Composites, residues, plastic, wood

1 Introduction

There are several industrial activities that use materials and processes that undermine the balance of the environment, as well as being pollutants by using exhaustible natural resources and have already started to show worrying levels of scarcity, leading the company to seek alternative solutions to this problem.

Currently, arise up alternatives and seeking ways to reconcile the objectives of economic, environmental and social, adopting environmental management programs as option gains ahead.

In general, when considering the environmental aspect recycling can help reduce the progressive accumulation of waste, the production of new materials, such as paper, which requires a greater number of cutting trees; emissions gases; aggression to the soil, air and water, among many other negative factors.

In the social sphere, recycling not only provides a better quality of life for individuals, through environmental improvement, but has also generated many jobs and opportunities in the area of recycling.

On the economic side, recycling contributes to the rational use of natural resources and the replacement of those assets that are likely to be reused becoming important study and the advent of new materials and forms for reuse or recycling.

Among the new materials available, may be listed in the WPCs - wood-plastic composites. They are made from wood waste and recycled thermoplastics and can be considered as composite echo-figuring a new class of materials with great commercial potential in many different applications.

A material shall not be classified as waste because most of its value as raw material, aiming to produce new products. Thus, the residue is treated as a byproduct of the production process (SAVASTRANO, 2000). When it comes to waste recovery, the trend remains the reuse of materials that take years to complete deterioration.

It can be argued that the emergence and development of production processes and products need to walk with the requirements of innovative sustainability urgent. Currently, it is remarkable that the discussions on sustainability assume operational nature.

The concept of "green operations" green operations or seeking the design and manufacture of products, developing processes rationally and intelligently, seeking the maximum reduction of waste found. This need is found in the industrial sector of environmentally suit has caused many companies to review their processes.

In fact, it is known that isolated actions will not solve the problems arisen by this residue and that the industry should try to close production cycle so as to minimize waste output and input of non-renewable raw materials (DORSTHORST; HENDRIKS, 2000).

This study was based on these aspects: clear plastic and waste wood and the possibility of reuse of such waste by applying the principles of sustainability.

2 Theoretical Foundation

The wood-plastic composites (WPCs) are made from waste wood and recycled thermoplastics and can be considered as eco-composites, although they did not look that would be considered natural. From the 90, the market recorded significant growth of this composite, doubling year on year to their demand, especially in niche markets where priorities as weather resistance and lower maintenance costs become relevant for the application of the material.

The term "plastic composites reinforced with wood" is now accepted by referring to the composites of thermoplastic matrix reinforced with particles or fibers, of wood. The thermoplastic composites reinforced with wood, in general, and as described ahead, consist of compounds that disperse particles of wood, usually thin, flour or sawdust called in everyday language, or wood fibers, thermoplastic brought to a state liquid melt, utilizing manufacturing techniques such as extrusion and injection molding.

The powder timber provides a reduction in cost, but will not automatically change to the better the performance of such materials. Recently, the uses of natural fibers have been interesting as it promotes character reinforcement for thermoplastic materials.

The term "eco-composite" is described by Forestry (2004) as a material that can both contain natural fibers such as hemp, sisal, jute or flax, as a natural polymer matrix. Compounds based on natural starch can be produced with the important advantage of biodegradability. A compound which is easier to recycle as a material comprising polypropylene, can also be termed as an eco-composite.

Much of the recent growth, development and use of WPCs was driven by initiatives funded by the Ministry of Agriculture and other groups associated with forestry and lumber industries in the U.S.A. Therefore, many of the companies involved in the production of WPCs in the U.S. are timber companies that have invested in product development and added these alternative materials to its product portfolio (OPITMAT Ltd and MERL Lta, 2003).

The new generation WPCs is produced by mixing wood flour or fiber & plastics to produce the materials that can be processed like a conventional plastic & has the best features of wood & plastic.

According to the same author, in general, the WPCs are a new class of materials with great commercial potential, as applications for the composite plastic-wood overlays, doors and windows, floors, doors and ceilings, interior panels, tubes, boats plates, frames, boxes, trash, mobile external and internal, recreational facilities, among others.

The future of wood plastic composites will depend on many factors. Ultimately, including new product identification, product quality, consumer perception & performance of these materials.

3 Materials and Methods

In this study was used for the production of composite wood-plastic (60mesh) derived from mixtures of *Pinnus Elliotii* and *Taeda*, besides the recycled polypropylene. The details follow in Figure 1 below.



Figure 1: Polymer recycled process of separation and cleaning.

After separation of the raw material were prepared four strokes being that for each 05kg of material was used. The formulations were 100% PP-T1, T2-90% PP +10% FM, 80% T3-PP +20% FM and T4-70% PP +30% FM.

Aiming the production of such composites (Figure 2), we used a brand extruder “Extrusão Brasil”, twin screw, co-rotating and $L / D = 40$, possessing eleven heating zones.



Figure 2: Pellets of wood-plastic composite in 30%, 20%, 10% and 100% PP FM, respectively.

After extrusion, the formulations stood in a greenhouse for a period of twenty-four hours subjected to a temperature of 60°C . After the drying step, the injection process was initiated for the preparation of specimens. The machine used was Romi Injection Practice, model 130, holder of four heating zones.

Tests of water absorption, tensile, impact melt index, based on ASTM - American Society for Testing and Materials, as well as scanning electron microscopy.

3.1 Test of Water Absorption

The test of water absorption and thickness swelling, based on ASTM D-570-98, showed that the composite endowed with 30% wood flour had a higher absorption rate due to the larger amount of organic matter. As can be seen in Figure 3, the composites showed an increase in weight change after one week of immersion.

The composite FM obtained a 10% variation in the total mass of 0.49%. In the case of the composite FM 20% by weight variation at the end of two weeks was 1.01% and 30% of the composite FM variation of total mass at the end of the process was 1.02%.

According to Yamaji (2004) in his doctoral research found that the composites with 30% wood sawdust also had higher water absorption, and water uptake is lower in composites with coupling agent, as this have an effect protection against water penetration. Here values on this issue in Figure 3.

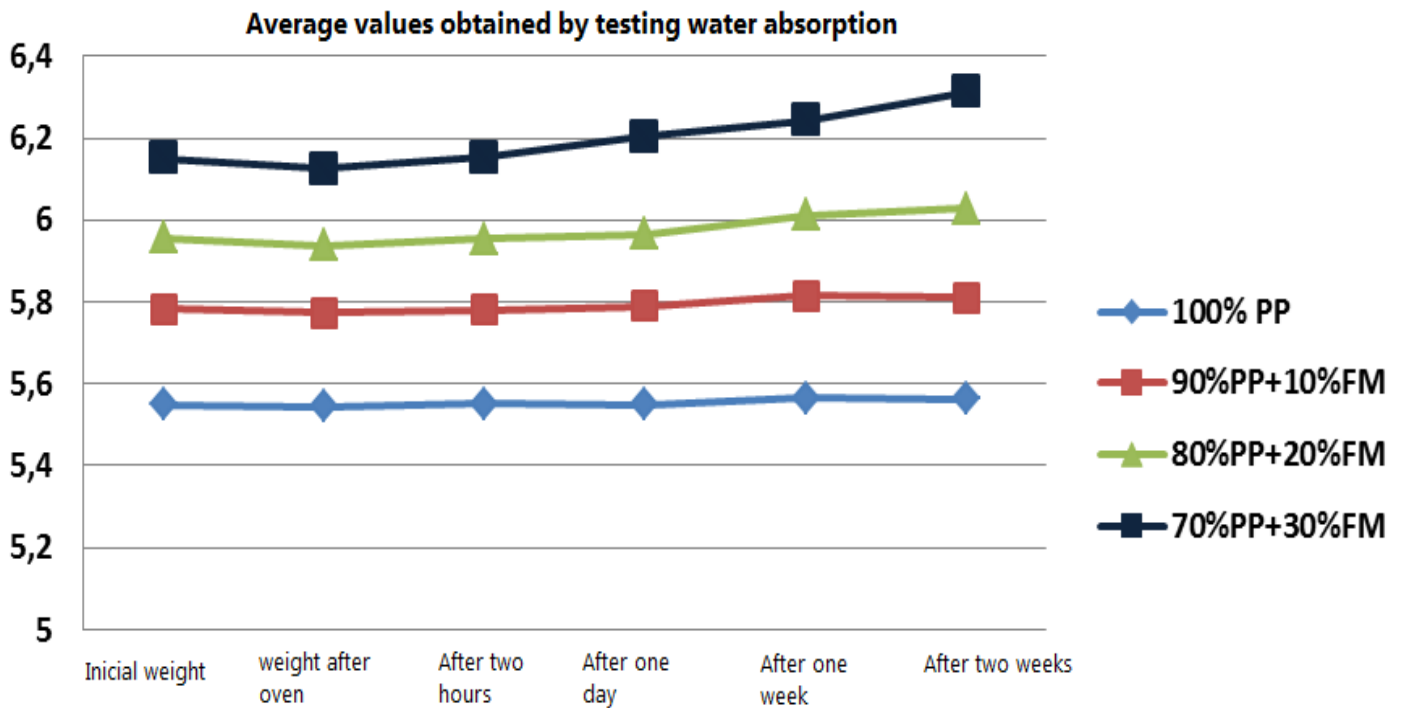


Figura 1: Graph of mean values of water absorption.

3.2 Tensile Tests

The tensile tests were developed based on ASTM D-638-10 and it can be seen that composites made with 30% wood flour showed lower elongation at break, due to the greater percentage of fibers in the composition, opposite the bodies proof 100% PP did not break (Table 1).

Tabela 1 – Average results obtained Média dos resultados obtidos para tensile test.

Traction	Traction (MPa)	Flow	Deformation Flow (%)	Elasticity Modulus (GPa)	Strain at break (MPa)	at Deformation at break (%)
1	22,12		9,17	1,00	18,80	367,01
2	21,64		6,05	1,39	20,28	9,90
3	20,97		3,84	1,79	20,59	4,59
4	20,13		2,62	2,17	20,06	2,76

The authors Caraschi and Leon (2002), mentioning that the properties of virgin PP, the injection temperature at 190 ° C for tensile strength is between 26.83 MPa and 30.72 MPa, and modulus of elasticity values lie between 1.514 GPa and 1.868 Gpa.

It can be seen that the properties of recycled PP for tensile strength, obtained in this work are 42.71% and 49.19% respectively lower. In modulus values are respectively 51.4% and 16.16% greater smaller, relative to virgin PP indices.

In this research, the impact test based on ASTM D-256-00, the samples of 100% polypropylene not broke. In test specimens with 10% wood flour, the impact strength was 41.06 J / m, most of the composite, as can be seen in Table 2.

Table 2: Results of impact resistance for the four traits.

Impact Strenght

Tracti	1		2		3		4	
	Average	Standard Deviation	Average	Standard Deviation	Average	Standard Deviation	Average	Standard Deviation
[J/m]	41,06	5,20	33,94	2,10	34,94	1,44	75,55	7,55
[J/m ²]	3998,1	506,4	3304,7	204,4	3402,1	139,8	7355,9	735,5
[kJ/m ²]	4,00	0,51	3,30	0,20	3,40	0,14	7,36	0,74

Corea et al. (2003) in his research, got a result of 36.3 J / m for the composite impact of 60% PP-Ho +10% +30% PP-MAH compatibilizer with FM. A value not very different from the result of 34.94 J / m for the 30% composite FM without compatibilizer obtained in this research.

3.3 Test of Melt Index

The melt index test was conducted according to ASTM 1238-10 and can be seen in Table 3 that the larger the percentage of FM in the composition, the lower the melt index compared to pure PP.

Tabela 3: Results test of melt index

Index of fluidity (g/10min)

Numbers	Measure I	Measure II	Measure III
1	30,0	30,0	30,0
2	21,3	22,3	21,8
3	16,4	16,6	16,5
4	10,4	9,5	10,0

It can be seen that the result obtained in this study for the composite 20% FM with g/10min result in 16.5, the best performance in fluidity compared to the composite PP +20% rice husk ash produced by Alfaro (2010) which obtained for the composite, a melt index of 15.5 g/10min.

3.4 Scanning Eletrocnic Microscopy

For the morphological characterization of composites by scanning electron microscopy, we examined the surface of the specimens subjected to tensile test.

The samples had a size of 1cm², with magnifications of 00x, 2.550xe 7.250x, visualized by Figure 4.

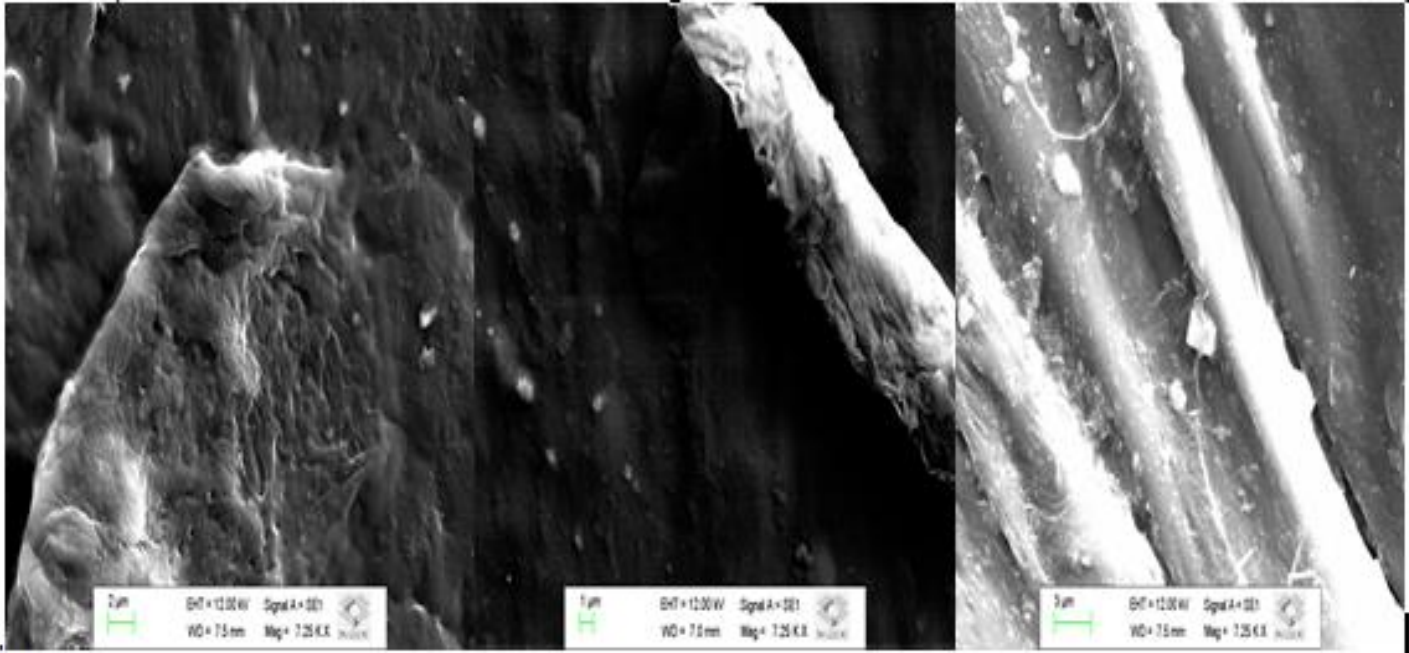


Figure 4: SEM of the composite FM 10%, 20% FM FM 30% at magnifications of 7.250x.

It is observed in the SEM in magnification 7.250x, the detail of the composite assemblage of parts. It is observed in SEM magnification 7.250x in which the composite FM presented with 30% added fiber. Machado et al. (2010) noted that wood dust acts as the polymer nucleating agent, confirming a higher degree of crystallinity of polymer embedding the wood dust.

4 Final Thoughts

The following work demonstrates the possibility of the production of wood-plastic composites using recycled materials such as polymer and wood waste that would be discarded by most wood industries, being a residue of finely.

Such waste could be being launched in nature or burned in the open, contributing to increased pollution.

Compared with other studies, it appears that the use of additives can improve some properties, but it takes a study to ascertain the economic feasibility of using this material as the intention is to use recycled materials.

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