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TOWARD NEW COMPOSITE MATERIALS STARTING FROM MULTI-LAYER WASTES

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ABSTRACT. Starting from multi-layer wastes new composite materials have been obtained. Physical properties of these materials and the hygroscopic behavior were established.

Keywords: *waste, multi-layer packages, plastic materials, composite materials*

INTRODUCTION

Wrapped products and merchandise represent a part of the modern world and facilitate our lives in various ways. However, the volume of wastes from packages dramatically increased in the recent times. This problem is more and more acute due to the diversity and the large number of these types of packages, which through their constitution demand a selective collection. Due to the non biodegradable nature of the packages waste, finding solution in order to put good use of them is absolutely necessary.

As a result of the problems caused by wastes, a series of researches are carried out. As far as the multi-layer packages are concerned, they are being studied not only from the point of view of materials recuperation [1-3] but also of obtaining new materials [4]. Due to the fact that the polyethylene terephthalate packages together with multi-layered ones are preponderant in the food industry, there are some researches concerning valorization through cracking [5].

Obtaining new composite materials from wastes represent a remarkable interest as far as there are some preoccupations in recycling paper, wood and plastic wastes. In their studies, Cui et al. [6], Caroll et al [7], Ichazo et al. [8], Selke and Wichman [9] pay a special attention to composite materials from wooden and plastic waste. Also, other researches regarding new composite materials, based on paper and polymeric resin, have been carried out [10, 11].

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RESULTS AND DISCUSSION

In this paper we propose a study on the properties of some composite materials obtained from multi-layer packaging wastes, containing aluminum, paper and polyethylene terephthalate (ex. juice packs). The multi-layer packages have been carefully washed and cut into small pieces so they could be shredded using a laboratory knives mill, GRINDOMIX GM 200. The obtained material was compressed at high temperature without any kind of bonding materials addition.

There have been carried trials at various grinding, pressure and temperature levels. In addition, the plate composition was also diversified. There have been produced plates from aseptic ground packages and plates with addition of recovered polyethylene from multi-layer packages with paper and plastic material content.

The composite material plates have been produced in a mould presented in figure 1. To ensure the heating of the material, the mould was endowed with an electrical resistance, which guarantees the required forming temperature.

Figure 1. The plates fabrication mould.

To obtain different plates we firstly vary only the pressure (between 2 - 20 MPa) and the temperature (maximums between 120 - 170℃) figure 2), and afterwards we have varied the composition by developing some mixing formula: shredded multi-layer packages and recovered polyethylene from packages which do not contain aluminum in ratios of 6.5:1 and 1:1.02, multi-layer package and PET flakes in ratio of 1.02:1 (figure 3).

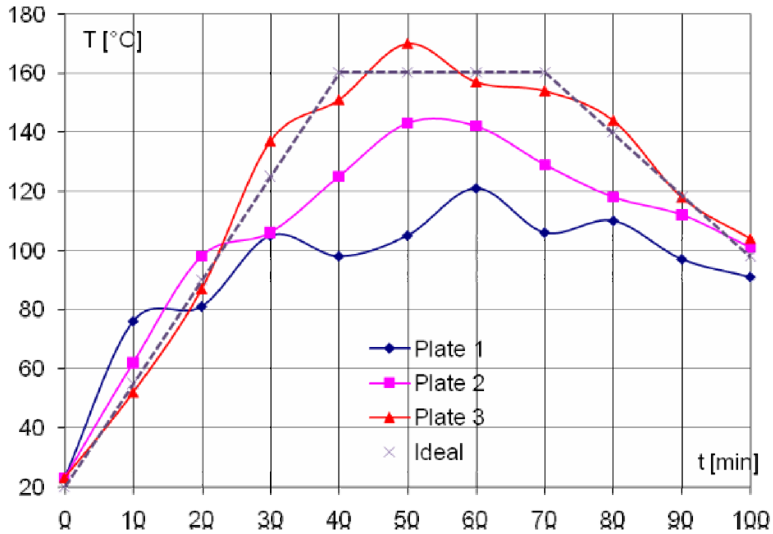

Figure 2. The temperature variation during the forming process.

Varying the composition of the initial mixture we obtained new composite materials with different porosity and permeability. In order to achieve this, we used polyethylene from multi-layer packages containing only paper and plastic material. The recovery of the polyethylene was made possible by stirring the mixture at 100℃.

a.	**b.**	**c.**
75 g multi-layer packages.	*65 g multi-layer packages*	*38 g multi-layer packages;*
	10 g polyethylene.	*37g PET flake.*
1:1	*6.5:1*	*1.02:1*

Figure 3. Plates obtained with various ratio formulas.

From all the obtained plates only those with polyethylene terephthalate addition had a brittle structure because of the PET flakes which remain unmodified in their structure.

The plates behavior in humid environments

The experiments performed to establish the hygroscopic behavior consists in dropping 2 ml of water on the plate surface and measuring the total absorption time (table 1).

It was observed that water does not penetrate in the areas covered with aluminum foil and the water front does not advance in that area (figure 4a. and 4b.).

Table 1.

The absorption behavior of the plates.

Test	**Water quantity [ml]**	**Absorption time [min]**	**Dispersion front $[d_i – d_0]$ * [mm]**	**Spot diameter at the total water absorption [mm]**
1	2	t_0=0	0	60
		t_1=10	10 – 15	
		t_2=15	10 – 25	
		t_3=20	20 – 35	
2	2	t_0=0	0	85
		t_1=10	10 – 15	
		t_2=15	20 – 25	
		t_3=27	30 – 45	

* d_o - the diameter at the time t_o; d_i - the diameter at the time t_i; i = 1 ... 3.

The experimental data showed that we have a 3.5 mm penetration depth after 20 minutes, see figure 4c (the plate thickness is 6 mm).

After the total absorption of the water, the plate showed a form alteration consisting in a slight growth of the material (figure 4b and 4c).

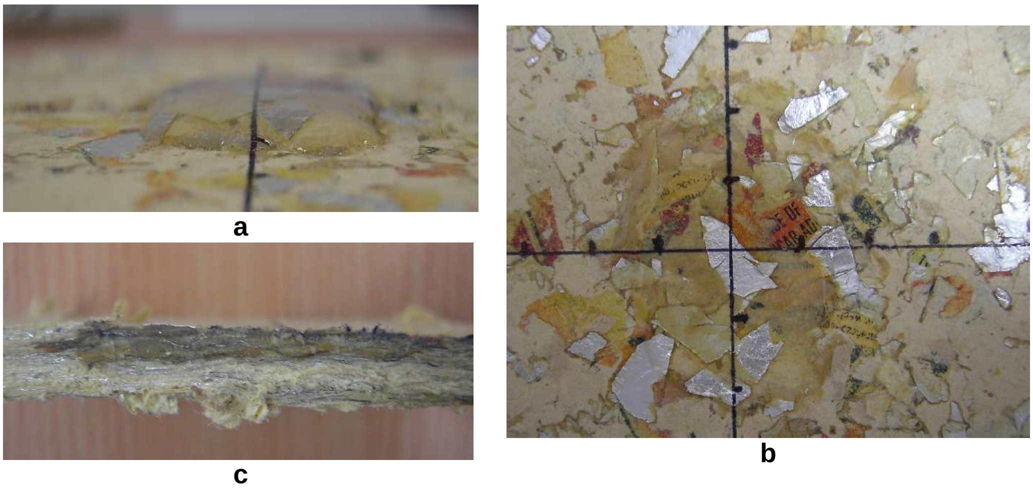

Figure 4. Water behavior of the plates. **a**. water drop on the plate surface; **b**. water dispersion on the surface, **c**. water penetration in the plate.

CONCLUSIONS

Taking in account the fact that we observed that the new composite materials we obtained, absorbed water, we can concluded that there cannot be used in humid environment like exterior building plating.

It was noticed the fact that an increased polyethylene ratio can improve the hygroscopic behavior, leading even to impermeable surfaces.

In the same time this plates can be used in the study of adhesive bonded joint assemblies.

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