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Waste of Molded Pulp Industry. Filler Panel Production for Construction

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Abstract

In the production process for producing recycled pulp cellulose, there are waste generated by the raw material entering the system. This residue is separated from the pulp by physical methods, and is mainly composed of plastics, paper, laminated papers and other materials in smaller proportions.
In order to recycle this waste, in this paper we analyze the viability of use in the production of insulated panels.
With the untreated residue extracted from the plant, panels of 30 cm side and thickness of approximately 6 cm were made. On these panels, parameters such as density and compression strength were evaluated for the study of the homogeneity of the material obtained.

Keywords: residue cellulose industry; panels; insulating

1. Introduction

Non-hazardous solid wastes are those solid industrial waste have not effective or potential danger to human health, the environment or public patrimony, when it is properly disposed. This group may include: food scraps,

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rags, cloth, wood, cardboard, paper and plastic scrap. The best solution for these wastes is their collection and treatment together with domestic waste.

In the last years, generation of waste from different industries has presented a significant increase. This is principally a result of the different technologies used in production processes, which allow to process increasing volumes of raw materials with the consequent increase waste to discard. They have also contributed to this problem other factors such as increased consumption and facility with which industries can place their waste at different landfills.

One of the immediate environmental problems facing the industry is directly related to the generation of waste and emissions. Traditionally, waste management strategies are based on end-pipe technologies. Thus, for example, solid waste is carried to landfills (no previous recycling). The economic and environmental costs of these treatment technologies are high, so are serious obstacles to the competitiveness of enterprises.

Research into the use of waste products from industrial processes is of interest both from the environmental standpoint, since that use reduces the environmental impact of the new material or product, and from a financial standpoint, in connection with the potential cost savings on treatment or disposal of those waste products. The construction industry provides broad scope for potential applications, since it uses large volumes of materials and a wide range features in those materials (mechanical, functional, and others). (Luis Agulló, 2006)

Cellulose and paper making industry generates important amount of waste material. The pulp and paper industry is characterized by four major processes: (i) chemical pulping (Kraft or sulphate pulping), (ii) mechanical and chemi-mechanical pulping, (iii) recycled fiber processing and (iv) paper-making related processes. By-products and residues from mechanical and chemi-mechanical pulping include wood, straw and reed residues, fiber rejects, excess sludges from external biological waste water treatment. (Ismail Demir, 2005)

The impact of recycling of paper and cardboard waste in industrial production of cellulosic pulp packaging is broadly significant from environmental and socio-economic point of view. (Area, et al., 2012)

The reuse of these components involves not only the preservation of forest resources, but also a decrease in the volume of solid waste and / or a reduction in the need for incineration. (Zanuttini, 2012)

The first step in any recycling process recovered paper and cardboard is the disintegration or repulp operation that aims to achieve a suitable fibrous suspension to be treated in the subsequent molding process (Àngels Pèlach, 2012). Fiberisation (repulping) is performed in the "pulper" in batch. Once generated recycled pulp, is proceed to the separation of pollutants by different stages of sieving and / or purification surge. Like the pulping stage, purging must be performed so as not to reduce the size of contaminants to not compromise their subsequent separation.

This paper proposes the possibility of reuse of the waste of the first separation of contaminants from the pulp, which in the company under study, is generated at 5 m^3 / day. The final disposition of this large volume of waste involves high environmental and economic costs.

The waste generated in the production process is closely related to the raw material entering the system. The quality of paper and cardboard is determined by the quality of the fibers (type of paper that is recovered) and the degree of contamination which has the burden of raw material to reach the processing plant.

The construction industry uses large volumes of raw materials and therefore can be an excellent receiving waste and could include very important waste percentage in their formulations.

There are a lot of work (M. Pelegrini, 2010) (Agulló, 2006) (Breslin, 1998) (Pelegrini, 2005) (Spinacé, 2005) on the use of this waste, in which it is heat treated, however no literature has been found concerning the use with Portland cement agglomerate.

In the context of this problem arises the idea of using waste from the first separation in the manufacture of building elements from a waste-binder composite as panels and building blocks, allowing the revaluation of this residue.

An alternative to be evaluated is the use of the composite material as a replacement polystyrene panel currently used as insulating material in double wall, supporting energy efficiency of buildings.

2. Experimental Procedure

To evaluate the feasibility of using this waste as material for the construction industry, it raised the agglomeration with cement paste. The residue used in this study is shown in Fig. 1. Should be clarified that, due to the heterogeneity of the samples taken in plant, it was necessary a drying process and classification in plastics, paper and laminated papers and other (Fig. 2).

Fig. 1. Extracted plant residue

Fig. 2. Separation and classification of the residue in (a) plastics, (b) paper and resin coated papers and (c) other.

In Fig. 3 shows the proportions of different components used in dosages tested for the realization of a square surface panel 900 cm^2 and 6 cm thick. For all panels generated were used 2.00 kg of waste.

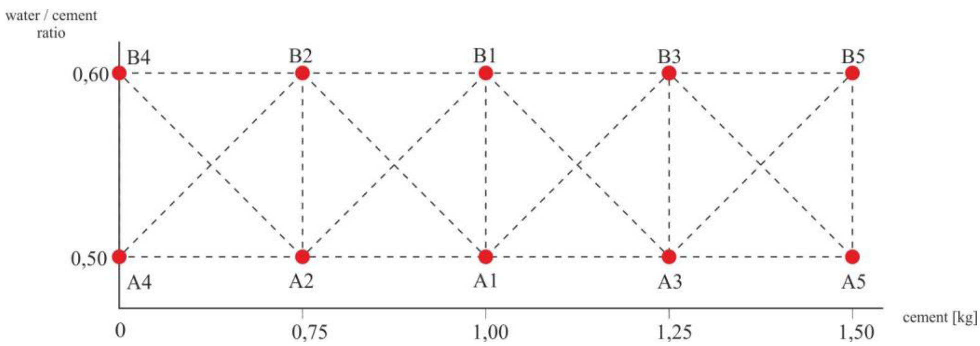

Fig. 3. Separation and classification of the residue in (a) plastics, (b) paper and resin coated papers and (c) other.

Regarding the evaluation of physical and mechanical properties of the panels obtained, the study focused on the analysis of the test of compressive strength as a parameter for measuring the uniformity of product produced. Fig. 4 shows the distribution of the cuts for the generation of sub-samples obtained from a panel.

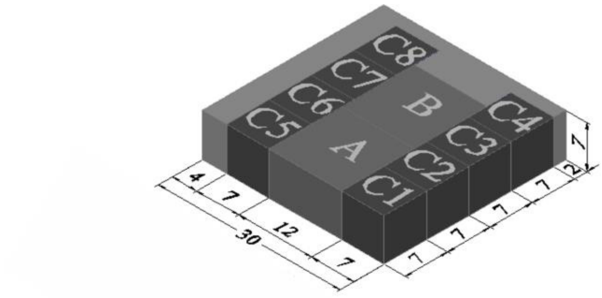

Fig. 4. Cuts distribution for generating sub-samples

To determine the age for the test panels was necessary to know the weight loss exhibited depending on the evolution of time to obtain comparable values between different dosages. Determining the value of resistance to compression was performed using a load cell of 10 tons, with 0.5 kg appreciation. As additional data and for comparison purposes, the density of each of the panels obtained was determined.

3. Results and Discussion

The analysis of sampling plant, concluded that residue fractionation is difficult because its composition depends only on the raw material entering the process, implying that the best alternative to recycling is to use the waste as a whole (without previous classification).

In Fig. 5 is shown, for example, a photograph of one of the panels produced with the agglomerate of the residue with cement.

Fig. 5. Panel finished

Fig. 6 and 7 shows the decrease in weight of each series of panels with time. For both water / cement ratios tested, the panels reached constant weight after 28 days of moldings.

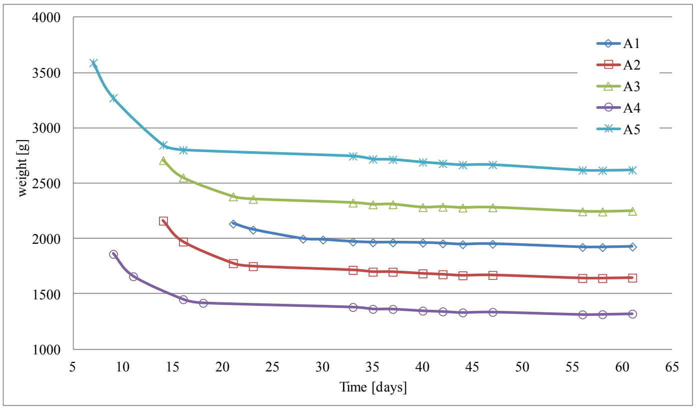

Fig. 6. Evolution of weight loss, water / cement ratio 0.5

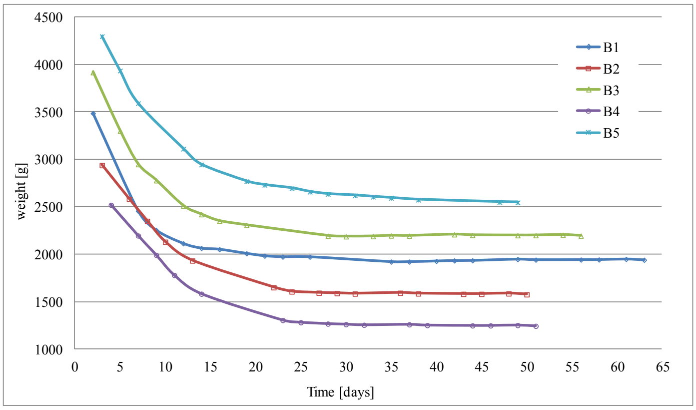

Fig. 7. Evolution of weight loss, water / cement ratio 0.6

In Table 1, Figure 8 and 9 are shown for all panels the results of compressive strength and density obtained through characterization tests.

Table 1. Results of compressive strength and density

Panel	density [g/cm³]	compressive strength [kg/cm²]
A4	0,205	0,359
A2	0,303	0,814
A1	0,304	0,701
A3	0,355	1,734
A5	0,411	1,969
B4	0,261	0,768
B2	0,297	0,869
B1	0,311	1,112
B3	0,404	2,062
B5	0,455	2,348

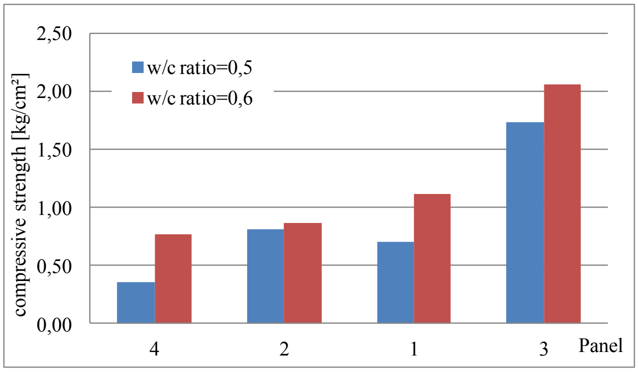

Fig. 8. Compressive strength of the panels

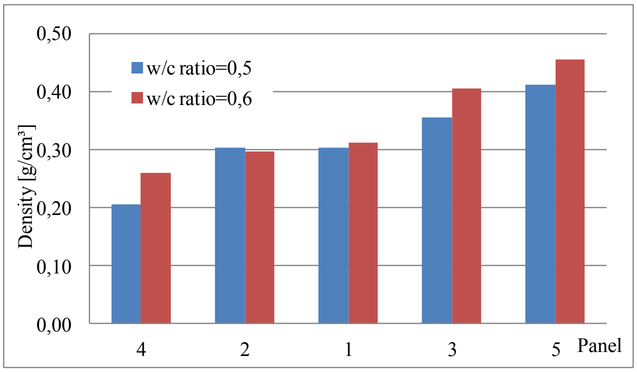

Fig. 9. Densities of the panels

The compressive strength results were statistically analyzed to draw conclusions regarding the uniformity of the physical property measurement and the optimum amounts of pulp added in molding, as evidenced in Fig. 10.

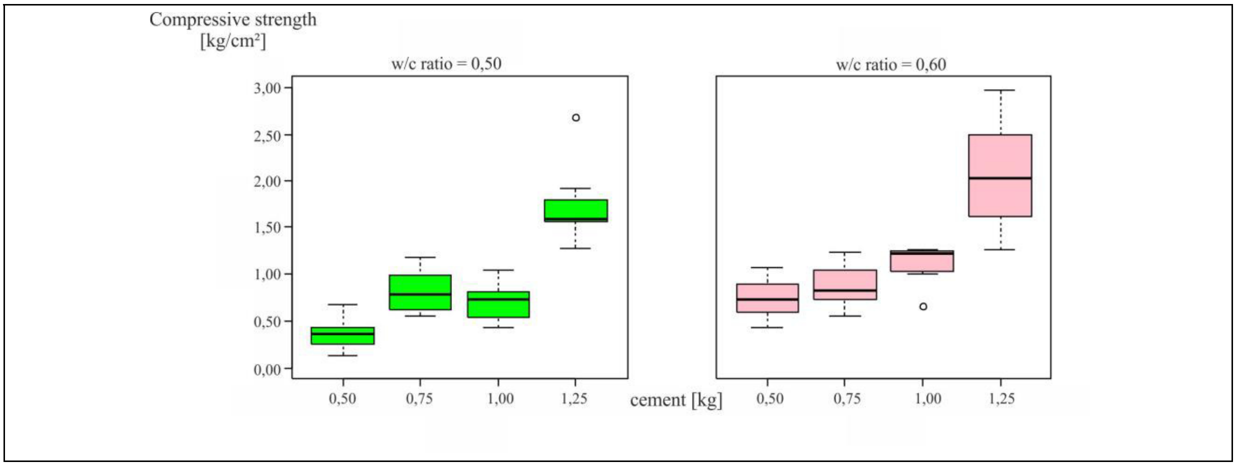

Fig. 10. Results of statistical analysis of compressive strength

Analyzing the results of deviation from the median for each panel it can be seen that there is significant variability in the majority of the elements tested. It is notable that the panel with higher cement content and higher water / cement ratio has the greater dispersion of values in the 8 sub-samples, indicating that this panel has greater heterogeneity in their composition.

As seen in the results for both water / cement ratios, as it increases the unit cement content translates into increased resistance to compression in the panel. On the other hand for the same cement content, higher water/ cement ratio implies higher resistance. For comparative purposes, it may indicate that this behavior is the opposite of a normal weight concrete in which case increased water / cement ratio indicates a reduction in the final strength.

4. Conclusions

According to the results of this evaluation, it may indicate the following conclusions:

It can be affirmed that the agglomeration of the residue with Portland cement to form alternative elements for construction is possible.

Another important aspect to consider is that due to the heterogeneity of the waste is not possible to separate it, so it is recommended to use together.

Regarding the evaluation of the weight loss was recorded for a period of 2 months may determine that all the panels reach stabilization around 28 days.

From the observation of density results obtained is possible to indicate that most of the panels have the same increased by increasing the cement content incorporated to generate the panel. However it can be note that there are no significant differences for the contents 0.75 and 1.0 kg of cement.

Both water / cement ratios studied an increase unit cement content translates into increased resistance to compression in the panel. Moreover, for the same cement content greater water-cement ratio will perform better resistance.

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