

Alternatives for Processing Plastics with Recycle Codes from 3 to 7

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ABSTRACT

Solid waste management represents a challenge for Puerto Rico. According to the Department of Natural and Environmental Resources (2019), more than half of the landfills have a closure order and only type one and two plastics are recycled on the island. On the other side, plastics will never biodegrade (Harris, 2019). This is why it is important to look for alternatives to decrease the impact of plastic pollution on the environment. This research developed an equipment to allow the use of plasma to process plastic. Ten samples of type five plastic were subjected to different time exposures to plasma to evaluate the performance of the equipment. It was obtained that by exposing the plastic to plasma for two minutes, two percent (2%) of its initial weight was reduced, with no significant reduction in volume. It is recommended to continue testing exposure time, and to continue with a phase 2 of the research, consisting on evaluating the residuals of the process (both solid and gas phases).

INTRODUCTION

Plastic is a synthetic material made from a wide range of organic polymers such as polyethylene, PVC, nylon, among others, that can be molded into shape while soft, and then set into a rigid or slightly elastic form. (Oxford University, 2018) Currently the plastic is one of the most used materials for the preparation of many daily used devices. Like kitchen utensils, for bottled water, packaging of detergents, food containers, among others. Plastic represents a large percentage of the raw material used in manufacturing. In containers represent 36%, in construction 11%, furniture of the industry of the automobile 7%, the agriculture 5%, the electrical sector 5%, the textile and the footwear 4 % and adhesives also 4%. (Rosario, 2011).

Puerto Rico has serious problems with solid waste management. According to the Department of Natural and Environmental Resources (DRNA) on the island is generated more than can be discarded. In addition, this agency said in a public hearing of the Cameral Commission for Economic Development, Energy and Planning that currently in Puerto Rico there are 29 landfills or landfill systems (SRS), of which 11 only comply with state and federal environmental regulations. The remaining 18 landfills are not in environmental compliance. Of these, 11 have a closing order from the United States Environmental Protection Agency (EPA).

Although there are laws in Puerto Rico for stimulating recycling (i.e Law 70 of September 18, 1992; and Law 411 of October 8, 2000), at present only plastics type 1 and 2 are recycled, and only the 11.3% of the solid waste generated in the island is recycled (Autoridad de Desperdicios Solidos, 2017).

The above-mentioned situations motivate to conduct the proposed research, which focus on devising innovative ways to recycle, process or dispose plastic solid waste in an environmentally friendly manner, in order to contribute to reduce the amount of plastic that ends up in landfills, thus reducing the environmental impact that the plastic may produce. The focus of the research will be plastics with recycling numbers from 3 to 7 that are not recycled in Puerto Rico.

OBJECTIVE

Develop an equipment that allows the exploration of the use of plasma as an alternative method for processing plastic, in order to verify if a new product is obtained that reduces the impact to the environment

METHODOLOGY

The main tasks developed were as follows:

- Study the available equipment in PUPR that may be used as components of the apparatus to process plastic with plasma.



Chamber before the modifications

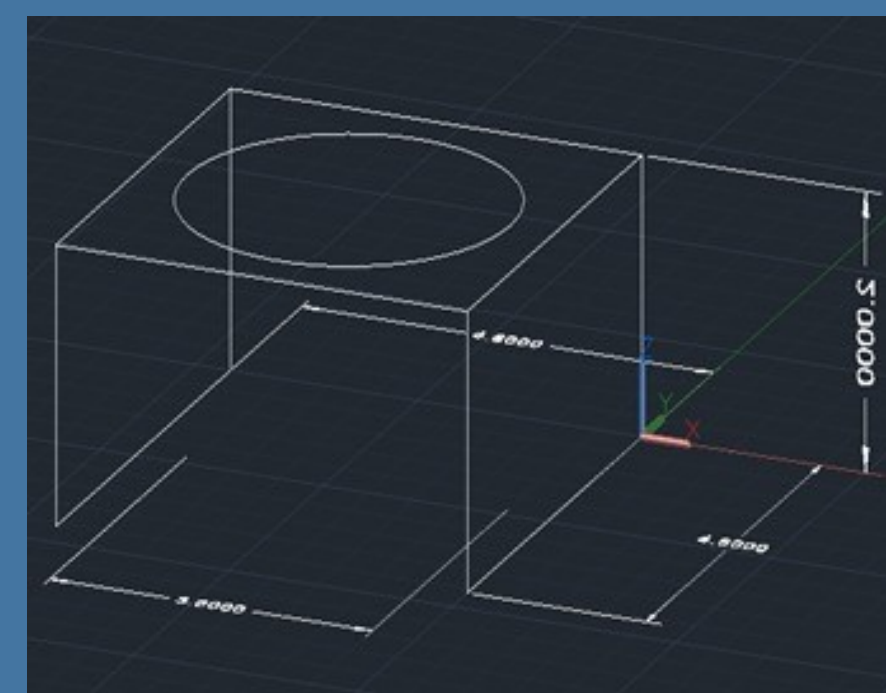


Ceramic

- Conceptual design the equipment.



The two pipes that appear in the original photo were removed and sealed. The original hole was sealed and another was made at the top.



Design of the support for the ceramic



Ceramic Container

- Acquisition of new required components according to design.



Plasma Cutter 80 S. Company: Everlast Generators.



Gas Washer. Company: Dreschel



ANSI Z87.1 Grey Glasses



3M™ Reusable Half Face Mask 6100



ANSI Heat Level 5 Glove



Particulate Filter P 100

- Equipment installation



Final equipment setup



Connection 220 in the Laboratory



Process of setting up the tests



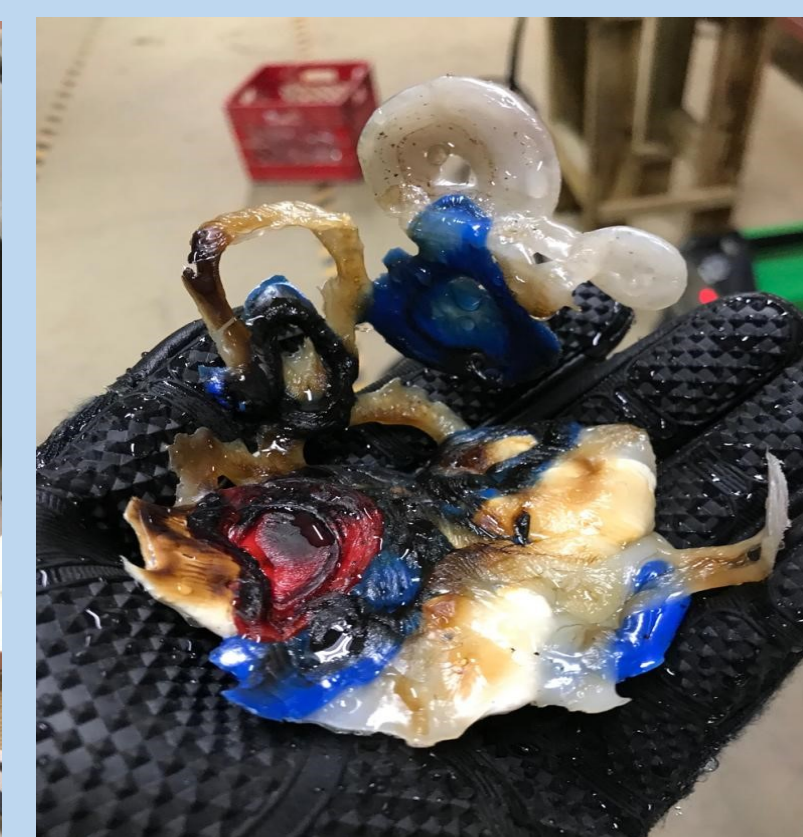
Performing the tests

DATA

Number of test	Initial weight	Final Weight	Difference	Percent
1	32.8775	31.8954	0.9821	3
2	32.7766	32.0156	0.761	2
3	30.8223	30.2987	0.5236	2
4	31.6150	31.1043	0.5107	2
5	30.0160	29.5037	0.5123	2
6	30.2911	29.5114	0.7797	3
7	31.5958	31.1205	0.4753	2
8	30.6250	30.1254	0.4996	2
9	29.1666	28.4358	0.7308	3
10	30.5986	30.1274	0.4712	2

RESULTS

Samples after plasma processing:



CONCLUSION AND FUTURE WORK

- An equipment for processing plastic with plasma was developed, constructed, and tested
- More tests are required to determine appropriate plastic particle size and plasma exposure time
- A second phase of the research will be to study the chemical contents of the residues (solid and gas) of the process, to evaluate if the new product is more friendly to the environment, the gases are not prejudicial, and also to determine the impact of the process in the change of volume of the solid residues.

ACKNOWLEDGEMENTS

- Special thanks to Professor O. Movil for his collaboration
- Salvador Montilla for his help in the laboratory
- Christopher Velazquez for helping with the tests
- Professor Gustavo Pacheco and Professor Angel Gonzalez for their mentoring.
- The program for the opportunity to develop this investigation

REFERENCES

- Consolidated Waste Management. (2018). Retrieved from CONWASTE: <http://www.conwastepr.com/>
- Environmental Protection Agency. (2018). Recycling. Retrieved from United States Environmental Protection Agency: <https://www.epa.gov/recycle/recycling-basics>
- Junta de Calidad Ambiental. (2015). Leyes y Reglamentos . Retrieved from <http://www.agencias.pr.gov/agencias/jca/Pages/default.aspx>
- Leblanc, R. (2018, May 10). How Long Does It Take Garbage to Decompose? Retrieved from The Balance Small Business: <https://www.thebalancesmb.com>