9th International Interdisciplinary Congress on Renewable Energies, Industrial Maintenance, Mechatronics and Informatics

Booklets

RENIECYT
Registro Nacional de Instituciones y Empresas Científicas y Tecnológicas
1702902 CONAHCYT

RENIECYT - LATINDEX - Research Gate - DULCINEA - CLASE - Sudoc - HISPANA - SHERPA UNIVERSIA - Google Scholar DOI - REDIB - Mendeley - DIALNET - ROAD - ORCID - V|LEX

Title: Conceptual development of a pulverizer for glass recovery

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Editorial label ECORFAN: 607-8695
BCIERMMI Control Number: 2024-01
BCIERMMI Classification (2024): 241024-0001
RNA: 03-2010-032610115700-14
Pages: 12

CONAHCYT classification:
Area: Engineering
Field: Engineering
Discipline: Mechanical Engineering
Subdiscipline: Mechanical Design

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CONCEPTUAL DEVELOPMENT OF A PULVERIZER FOR GLASS RECOVERY

INTRODUCTION

A lot of solid waste in urban territories has occupied too many land environments of people. As municipal solid waste can't diffuse quickly, the contamination threat they pose to the earth has long term potential. The unsafe parts in solid wastes can make potentially dangerous nature, individuals, and creatures. These ecological risk impacts can spread from people to the entire species; lastly, break the entire eco-equalization and harm our common assets(1).

Figure 1. Landfill of garbage(2).

Figure 2. Garbage on land.(3)

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INTRODUCTION

Glass is among the most abundant materials on earth obtained primarily from silica. With the development of science, technology, and society, it has become one of the most important inorganic materials[4]. Due to the high cost of cleaning and colour sorting, the recycling rate for glass bottles is only about 25% and most waste glass is sent to landfill as residue; since glass is not biodegradable, landfills do not provide an environmentally-friendly solution[5] (Tittarelli, Giosue, & Mobili, 2018).

Figure 3. Types of glass waste [6].

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INTRODUCTION

The interest in providing a solution to the reuse of evacuated pipes and cooperate in the reduction of this type of waste, is what motivates to make a prototype that allows to crush and/or pulverize the glass of these elements, to reuse the material and take advantage of its properties, among which stands out its resistance to chemical attacks[7].

Figure 4. Failed evacuated pipes.

Figure 5. Crushed glass[6].

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METHODOLOGY

For the development of the prototype of the pulverize machine, the phases of the process contained in the theory for the mechanical design are considered[8], and schematically represented in the following figure.

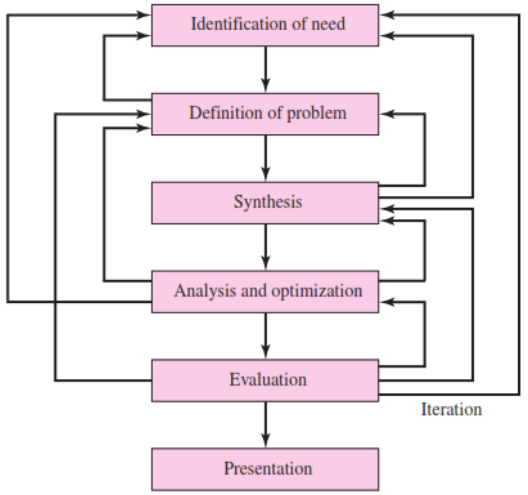

Figure 6. Phases of the design process that recognize multiple feedback and iterations[8].

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METHODOLOGY

The main application of recycled glass is in the construction industry, as fine aggregate (sand)[9] or coarse (gravel) and in some cases as a cementitious material[10]. Particle size varies according to the type of aggregate, fine aggregate consists of natural sand or crushed stone with most of its particles smaller than 5 mm (0.2 in.), coarse aggregates consist of one or a combination of gravels or crushed stones with particles predominantly larger than 5 mm (0.2 in) and generally between 9.5 mm and 37.5 mm (3/8 and 1 ½ in)[11].

Figure 7. Pulverized and crushed glass[12].

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METHODOLOGY

There is a wide variety of crushing machines and mills, which have modifications regarding the main elements, dimensions and characteristics; these provided information regarding the shape, size and components to be considered for the development of the conceptual design. From the review carried out, different sketches were generated to develop the machine that will crush/pulverize the glass from the evacuated pipes. The generation of ideas is an important part for the final selection of the conceptual design and it is the one that is developed in this stage of the mechanical design.

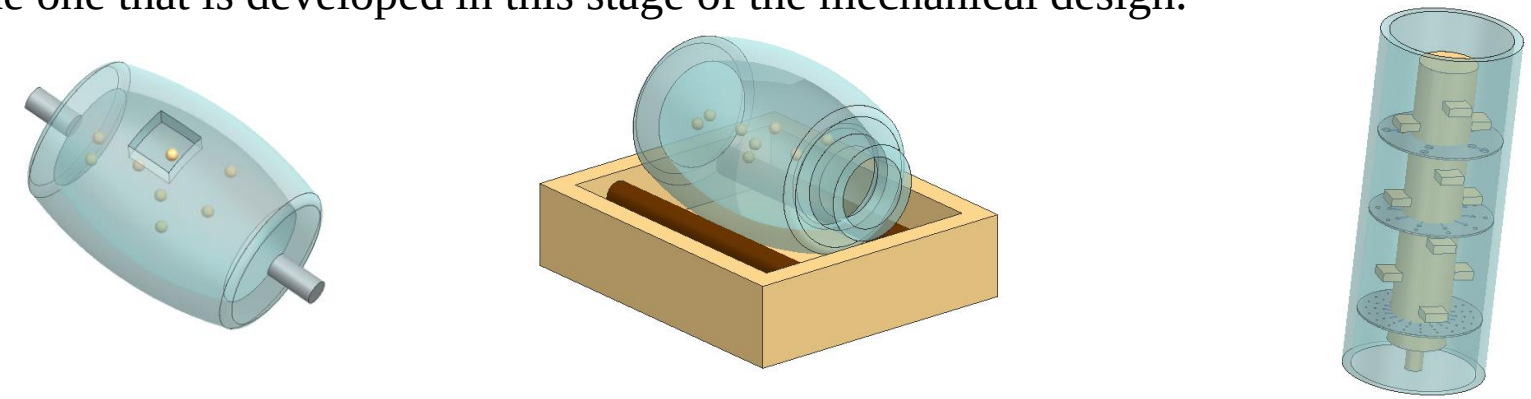

Figure 8. Conceptual designs for the pulverizer.

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METHODOLOGY

The following table summarizes the elements and components that were analyzed to define the final prototype.

No. Prototype	Elements	Method	Components/equipment	Material	Size
1	Steel vessel	Crushing (steel shot)	Two phase motor	Solera	Regular*
2	Rectangular casing	Crushing/pulverizing (hammer)	2 Engines	Solera, steel	Robust +
3	Rectangular casing	Crushing (hammer)	Hydraulic pistons, oil reservoir	Steel	Robust
4	Steel casing	Pulverization (stone grinding wheels)	Motor, shaft with fins	Steel	Regular
5	Steel vessel and casing	Crushing/pulverizing (steel shot)	Motor	Steel	Regular
6	Rectangular casing	Crushing (shaft with hammers)	Motor, shaft with hammer	Steel, solera	Regular
7	Cylindrical casing	Crushing/pulverizing (hammer shaft)	Motor, shaft with hammer	Steel, solera	Robust /regular

* Maximum 1 m^3, + Greater than 1 m^3

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RESULTS

According to the different conceptual designs that were being made and considering the feasibility in terms of resources to carry out the machining, purchase of mechanical and electrical elements and the necessary material for the construction of the prototype, the following is the design that is considered viable for its manufacture. This prototype consists of a tube in which steel projectiles will be introduced, which at the time of spinning will hit the material (glass) to pulverize it, the movement of the rotation will be done through a motor, the device will be placed horizontally and will be fed through the lid at one end of the tube.

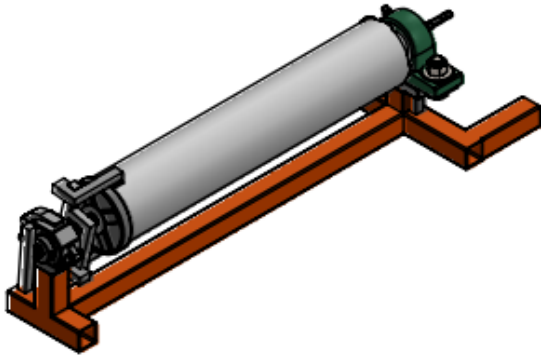

Figure 9. Final conceptual design.

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CONCLUSIONS

A conceptual design was obtained from the review of existing mechanisms and equipment, allowing to generate an idea of easy manufacture and operation, it is considered of low cost because it does not require special materials for its manufacture and that are known to be found in the domestic market. As the prototype is used for glass pulverization, it can be improved in terms of particle size, run time and amount of material obtained.

Also, there was the opportunity to develop design thinking, following the phases of mechanical design theory, with a view to the improvement and innovation of equipment necessary for the development of the present research project. In addition, the collaboration and follow-up of the participants during the development of the conceptual design allowed the definition of the final prototype.

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