Decentralized Household Food Waste Management Solutions

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Introduction

The scope of this project was to design a modular household food waste management system for communities with limited access to centralized waste management facilities. Many technologies were considered including traditional composting, gasification and anaerobic digestion, but ultimately bokashi fermentation was the chosen system. Bokashi is waste management technology that allows the consumer to dispose of their waste properly in the comfort of their home without the risk of foul odors.

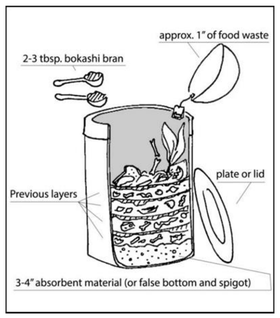

Figure 1. Bokashi Process (SWRC, n.d.)

Figure 2. Bokashi Base Design (Bokashi Living, 2015)

Design Process

- Based on the project objectives, the waste management solution was to be modular, efficient, safe, easy to use, convenient to operate, and able to be maintained with little technical experience.
- Conducted customer surveys to determine what aspects of the bin could be improved upon, and how.
- Components of the bin were investigated in more detail including the grinder, the insulation in the walls, and the filter to mitigate odor.

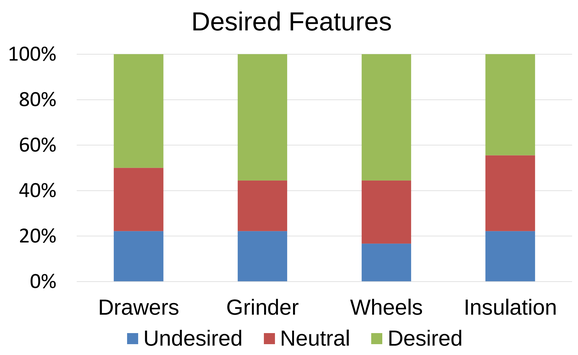

Figure 3. Survey Results of Desired Features

Details of Design

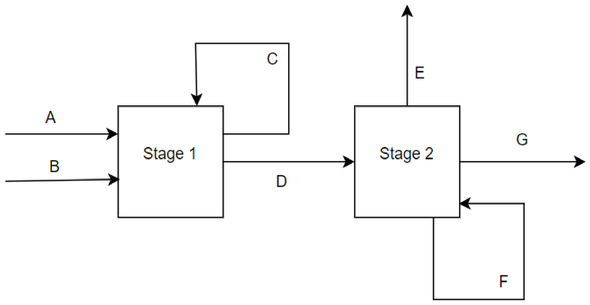

Figure 4. Bokashi Process Flow Diagram

Effective Microorganism Composition (~20% each)

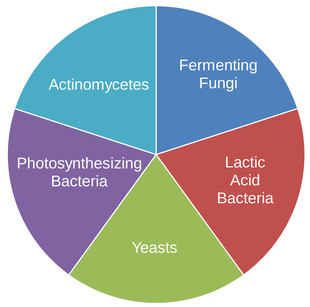

Figure 5. EM Composition

Biogas Composition

99.9989% CO_2
0.001% NH_3
0.0001% H_2S

To help manage biogas output, a filter was implemented into the design.

Table 1. Bokashi PFD Legend	
A	Food waste is added to the bin as needed in stage 1.
B	Effective microorganisms (EM) are sprinkled onto the waste at roughly 1" in height.
C	Compress whenever food and bran are added.
D	The bokashi bucket is full and must be sealed. Fermentation begins in Stage 2.
E	Biogas emissions are released when the lid is opened
F	Leachate drained every 2 days.
G	Ferment 2 weeks. Then trench in the backyard.

1 mm thick polystyrene insulation

Figure 6. Polystyrene Insulation (Nuclear-Power, 2022)

Leachate Composition

The leachate is composed of primarily lactic acid.

The pH ranges from 4.5 to 5.

The leachate from the bokashi bin may be diluted to neutralize the pH and create a liquid fertilizer full of essential nutrients including phosphorous, nitrogen, and carbon.

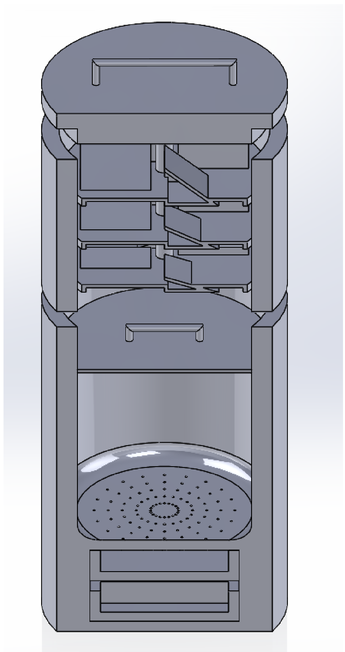

Figure 7. Cutaway View of the Proposed Design

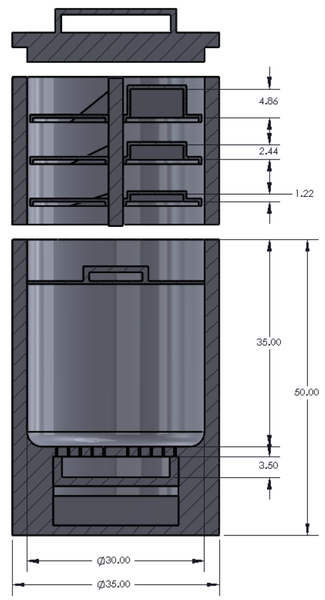

Figure 8. Dimensioned View of Proposed Design

Economic Analysis

- Cost of material: $211.03
  - Cost includes material costs for two bins, one handpress, the grinder, the insulation and the air filter.

The original bokashi bin is $149.50 new, the optimized bokashi would need to retail at higher price due to the added benefits that come with the bin. Those benefits are:

- A grinder to remove the user from needing to cut food waste making it cleaner for the user
- Insulation to increase the areas the bin can stored
- An air filter to remove smells during the fermentation stage
- Wheels for better accessibility

Conclusion and Recommendations

- The bokashi bin has been optimized to meet client demands.
- Compared to the market brand, the optimized bokashi bin now includes
  - Two drawers to collect leachate
  - 1 mm thick polystyrene insulation
  - A grinder to optimize mixing food waste
  - A filter to reduce the quantity of biogas lost when the system is opened,
- It is recommended that the optimized design should be built and fully tested in a pilot plant.

References

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