Scaled-up Heating System for Microbial Compost Product

2024 Design Project ME 4015-4016

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COLLEGE OF ENGINEERING MECHANICAL ENGINEERING VIRGINIA TECH

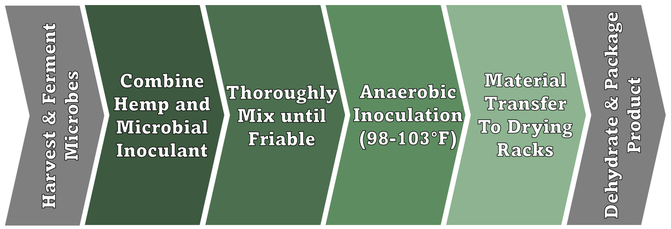
Background

Kenkashi, a local company, creates a compost accelerant product which:

- Speeds up composting process
- Allows users to compost a diverse range of food waste

Production Process

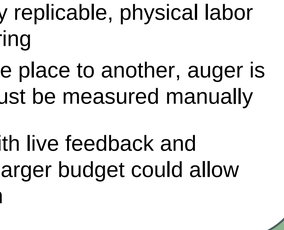
Goal: combine highlighted steps with new system



Problem Statement

- Kenkashi can only produce ~7.5 lbs of product at a time, but want to scale up 300%
- Previous company issues with upscaling:
  - Maintaining temperature range
  - Liquid & solid material separation
  - Maintaining cost-effectiveness
  - Minimizing physical labor

Current and future batch sizes



Objectives & Requirements

- Easily replicable design
- Integration into current process and site
- Minimal energy use
- Can be cleaned
- Does not introduce chemicals to product, maintaining "Garden to Gut" promise

- Material maintains 98° – 103° F temperature range
- Evenly distributed temperature throughout drum
- Prevention of liquid separation
- Anaerobic inoculation conditions
- Resultant mixture is evenly friable
- Motor arm raises and lowers easily
- Barrel mobility around site for material transfer

Conclusions

Did design meet requirements and objectives?

Yes - To improve mix quality or reduce electricity usage, the auger can be turned on or off as often as client desires

What are positives and negatives of system?

Positives: Mechanical simplicity = easily replicable, physical labor is reduced by automatic raising & lowering

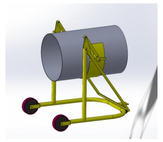
Negatives: Difficult to transport from one place to another, auger is loud when powered on, temperature must be measured manually

How can product be improved in future?

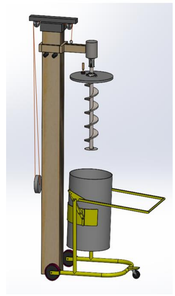
Built-in temperature probes on barrel with live feedback and alert systems, smartphone integration, larger budget could allow for brushless motor and noise reduction

Design

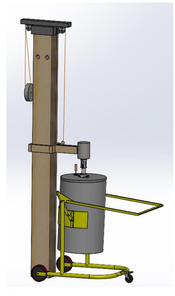
Original Design



Horizontal position for cleaning, loading, unloading

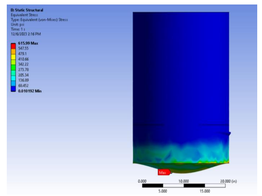


Open position for setup

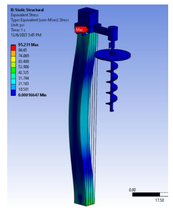


Closed position for mixing & heating

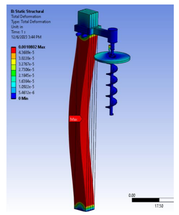
Analysis



Yielding safety factor: 15

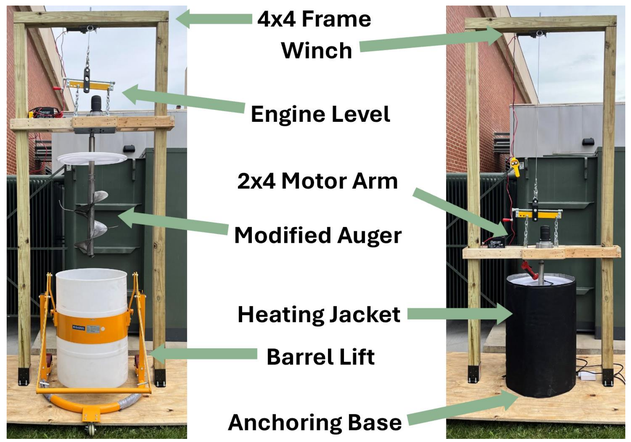


Yielding safety factor: 10



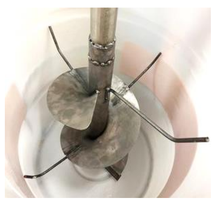
Max deflection: 0.001”

Final Design

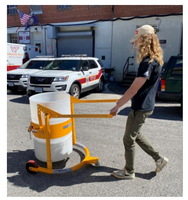


Open position for setup

Closed position for mixing & heating



Modified Auger inside barrel



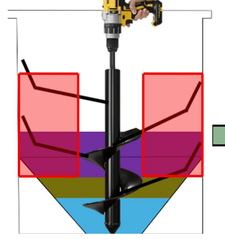
Material in transit

Testing

Torque Experiment

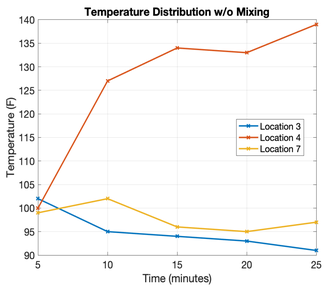
Rented auger rated at 51 ft-lbs validated sufficiency of electric auger drive instead of high-torque gearbox

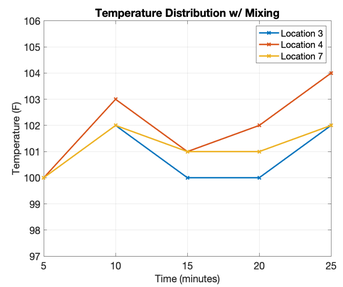
Color Mixing Experiment



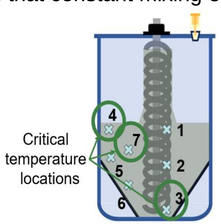
Arms added to auger for additional agitation in previously stagnant red zone

Temperature Distribution Experiment





Found that constant mixing evens out temperatures throughout drum



3 critical temperature locations identified using small-scale model

- 4: most sensitive to external heat
- 7: average
- 3: least sensitive to external heat