Introduction

The purpose of the Biomass Compactor is to create biomass bricks that would be sold as either a heat source or animal feed. Bricks would either be 5 lbs. for fuel bricks or 2.5 lbs. for animal feed. In order to commercialize the bricks, the customers desired a machine with the capability of producing 720 bricks per hour.

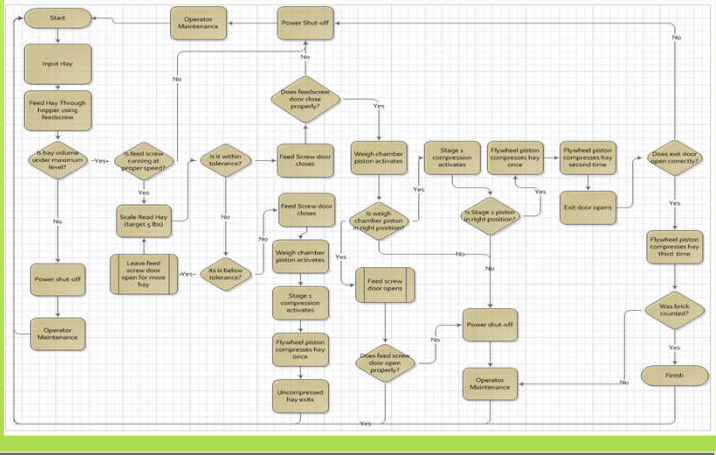
Background

In the spring of 2013, Overmoyer Farm and Comtech approached Multidisciplinary Senior Design team 13432 with the idea of a biomass compactor. The customers had designed and built a prototype; however, this machine did not have the capacity required for the mass production of bricks. The team extensively researched the few existing biomass compressing solutions and collected fundamental data about the forces required to reach the density desired by the stakeholders. In addition, the team gathered and analyzed data provided by the customers, which included visiting the site where the prototype is located. Furthermore, the team tested the biomass, as well as other similar materials, to acquire even more information.

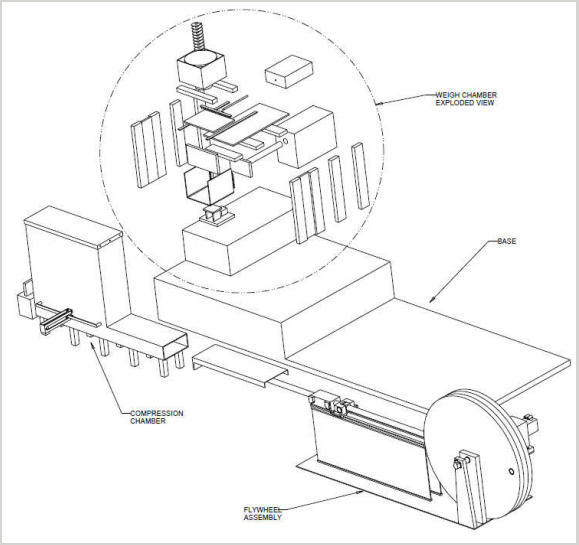
Customer Needs

The design is a production version of the Biomass Compactor based on NYSERDA grant "Industrial process for Hay conversion into Alternative Energy Source and Food for Animals"
Biomass Compactor system must be safe to operate
Biomass Compactor System should consists of key design elements that enable efficient energy usage through the process of compacted biomass product
Biomass Compactor system should be productive in terms of units produced per time
Biomass Compactor system must be easy to operate
Biomass Compactor system must be easy to maintain.
Biomass Compactor system must not be loud
Biomass Compactor system must be easy to install and uninstall from customer/client location
Biomass Compactor system must be able to produce two weights of compressed bricks (of the same size)
Biomass Compactor system must be able to process several forms of input Biomass

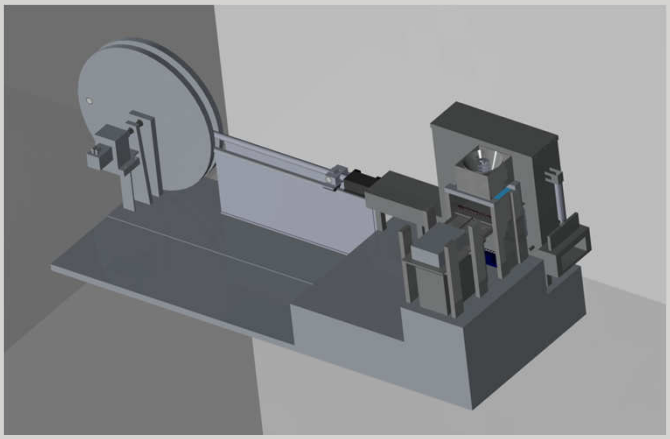
System Flowchart



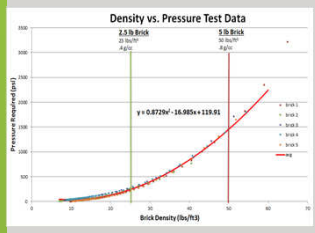
Machine Model

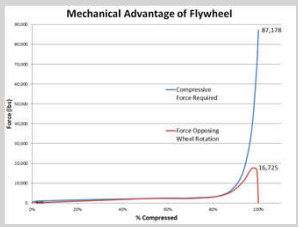


Biomass enters the system through the hopper at the top of the machine. It is fed down into the weigh chamber until the 5 pound mass is achieved. From there the first stage of compression moves the biomass to the compression chamber. The flywheel piston finalizes compression in two strokes, and pushes the brick out of the system on the third stoke. Bricks need to be tied in order to maintain the full level of compression.



Flywheel Design





Conclusions & Recommendations

- Not including the cost of the machine or labor, the constant cost per brick is $0.87. At the selling cost of $1.50 proposed by the customer, this would be a 73% profit.
- However, the cost of heating oil would have to be at least $5.81 per gallon to make this option economically preferable to consumers. As current US heating oil costs hover below $4, the bricks would have to be sold at less than the desired price.
- While the cost of including additives necessary for feed bricks was not fully determined, it is likely that feed bricks would be more feasible because they would be more marketable at a profitable price.
- Preliminary data gathered by the customer regarding the potential flywheel design and the properties of compacted biomass was successfully confirmed in this project. The high goal of a throughput of 720 bricks per hour was also achieved.

Authors/Group members (from left): Rebecca Peterson (ME), Jackson Standard (ME), Joshua Miles (ME), Stephen Hogan (ISE), Danielle Absi (ME), Angela Wambach (ISE), Sean Cooney (ME), Leila Rozenman (ISE), Akhil Nangpal (ME), Eric Wood (ME), Lee Polott (ME)

Specifications

Mechanical Specifications

Dimensions:	13' x 5' x 6'
Weight:	2,000 pounds*
Hopper Vol.:	640 in^3
Chamber Dims.:	5" x 12" x 36"
Stroke Length:	40 in.
Flywheel Diam.:	48 in.
Loading Tol.:	+5%

Production Specifications

Takt Time:	5 seconds
Production Rate:	720 bricks/hour
Power/brick:	1,004 W
Input Voltage:	208-240 V
Feed Motor:	.5 HP @ 1750
Flywheel Motor:	14.8 HP @ 1750
Peak Compress.:	87,178 lbf

Output Specifications

Fuel Brick	
Dimensions:	3" x 5" x 12"
Weight:	5 lbs.
Energy Density:	360,985 BTU/ft^3
Food Brick	
Dimensions:	3" x 5" x 12"
Weight:	2.5 lbs

Acknowledgements: Team 13423 would like to thank customers Mr. Jeff Gutterman, Dr. Roman Press, Mr. Francis Overmoyer, and Mrs. Mary Murphy for their support, guidance, and industry specific knowledge. Special thanks also go out to the following RIT faculty: Professor Edward Hanzlik for providing the young engineers with guidance and general engineering knowledge during the project journey; Professor Stephen Boedo for in depth knowledge regarding flywheel design, performance, and behavior; and Professor John Wellin for professional input during the design process.

Biomass Compactor Design Study

MULTIDISCIPLINARY ENGINEERING AT RIT
MERIT
Senior Design