Portable Manual Hydraulic Biomass Compactor

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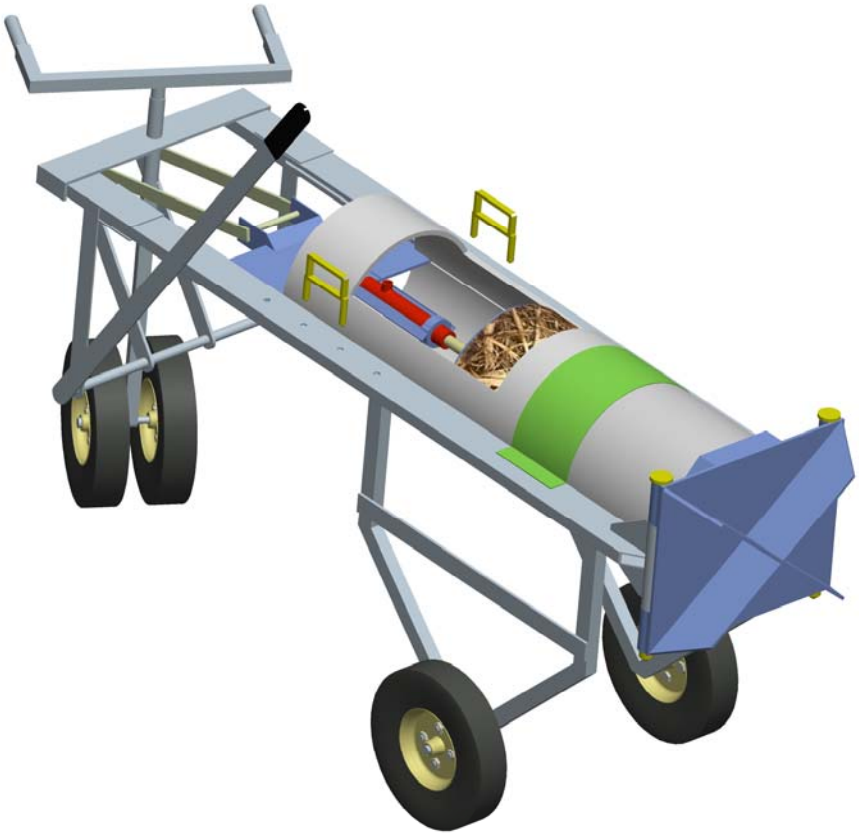
Agricultural And Biological Engineering

Project Definition

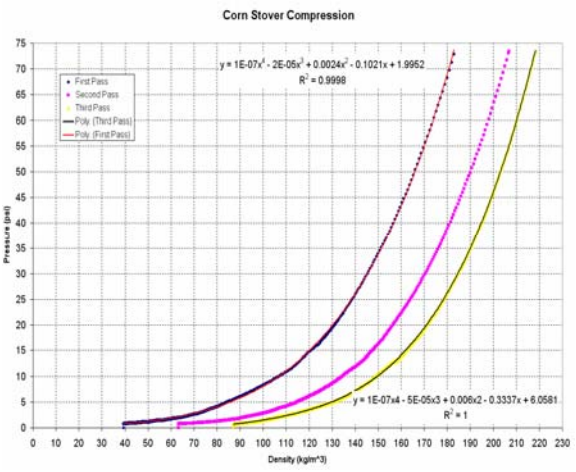
The goal of this project was to design and fabricate a portable manual hydraulic compactor for biomass and waste material densification. The project was aimed at enhancing the research work conducted in the laboratory of biomass utilization. The project activities included equipment design, equipment fabrication, product testing, and demonstration. The compactor termed 'Biopak' will be used for densifying biomass samples collected from the field in situ to enable cost-effective handling, transport, and storage for long-term research studies.



Objectives:

The major goal of the project was to design and fabricate a portable manual hydraulic compactor for biomass and waste material densification. The equipment requirements were:

- No mechanical or electric power required.
- Equipment can be transported on the bed of a pick-up.
- Equipment can be maneuvered on the field by someone weighing ~ 120 lbs.
- Compaction by manual hydraulic mechanism is preferred.
- Compaction should achieve a bulk density of approximately 200 kg/m3.
- The prototype development must be within the budget of $1000.



Compaction Testing and Data Collection

- Multiple cycle compaction on dry corn stover (3 cycles) with MTS (Universal compression and tension tester).
- Purpose: Measure density of compacted sample to calculate amount of force needed in the design and observe amount of spring back.
- Results:
Density achieved = 190 kg/m3;
Spring back = 15%;
Design force = 8000 lbs.

Compaction Device

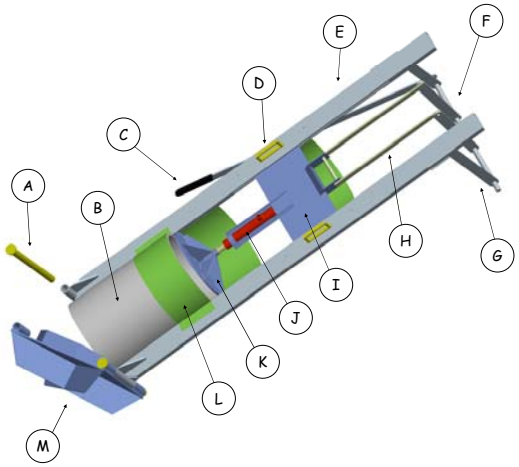
2 Stage Compaction Process

-Lever Arm and Hydraulic

-Hydraulic unit will apply 4 ton of force achieving the requested density.

Material will be compacted into a 12" diameter tube 18" long. A 5 gallon bucket may also be used in place of this tube section for high moisture biomass.

Baling twine will be used to maintain sample shape and dimensions.



Summary of BioPAK Components:

A. Unload Gate Pin
B. Containment Tube
C. Pre-Compaction Lever
D. Position Adjustment Pin
E. Frame
F. Position Adjustment Linkage
G. Lever Mount
H. Position Adjustment Linkage
I. Hydraulic Ram Mounting Plate
J. Porta-Power Hydraulic Ram
K. Compaction Plate
L. Compaction Tube Supports
M. Unload Gate

This model created in Pro-Engineer Wildfire

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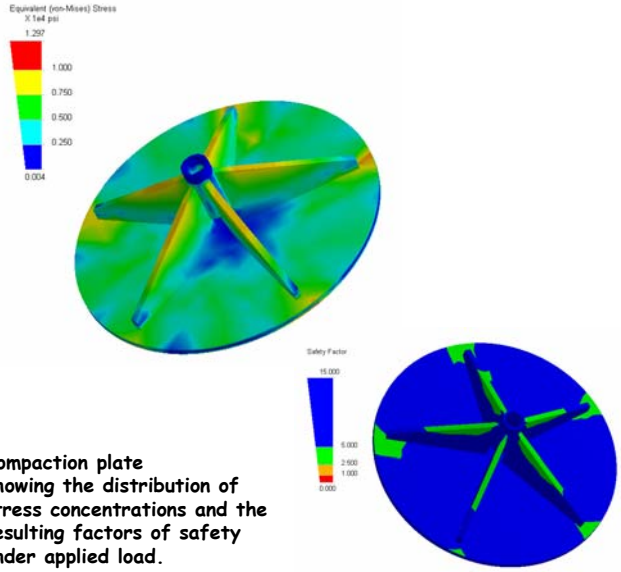

Compaction plate showing the distribution of stress concentrations and the resulting factors of safety under applied load.

Analysis of Device Components

Due to the high forces experienced by this device, Finite Element Analysis was employed to ensure all components could sustain the maximum stresses experienced under load.

A safety factor of at least 2.5 was also required during this analysis for unexpected stress concentrations or load not analyzed by the simulation.

Above figures were analyzed and created in ANSYS 8.1 Workbench

Applications for Compactor Operation

Biomass feedstock utilized by research lab

- Corn stover
- Switchgrass
- Sorghum
- Wood Chips and Saw Dust

Other applications for use at home

- Household waste
- Yard waste
  - Leaves
  - Grass clippings


Corn Stover


Switch Grass


Sorghum


Household Waste


Leaves


Grass Clippings

Impact of Product

- Aid in biomass feedstock research
- Allows for biomass samples to be easily and cost effectively collected.
- Provide way of reduced cost of transportation of samples to the lab.
- Reduces cost of biomass storage by reducing amount of space required.
- Reduces amount of space needed to store waste at home.

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