PURDUE UNIVERSITY

CAPSTONE/SENIOR DESIGN EXPERIENCE 2017

Grain Bin Unloader

Agricultural & Biological ENGINEERING

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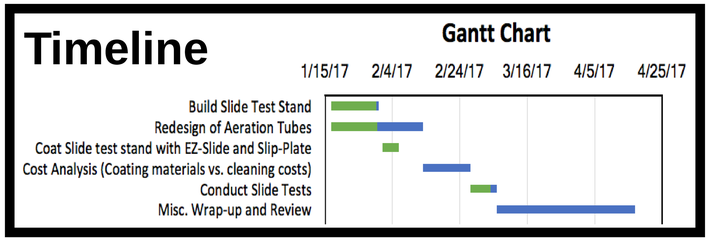
Background

Archer Daniels Midland (ADM) has been tasked with a zero-entry policy into grain bins across their company. Grain building up in the grain bins makes it so the bins should be cleaned out before other commodities can be put in them. With no one being able to enter the bins, it makes it very difficult to clean the bins out. ADM would like to approach this problem to figure out why the grain sticks and how to keep it from sticking, so that the bins no longer need to be cleaned out in-between various grains.

Timeline



Problem Statement

ADM wants to see a conceptual study of a device to clean grain bins that does not require entry into the bin. This would be a review of current commercial offerings and an ideation study, trying to develop as many viable alternatives as possible for the problem.

Objectives

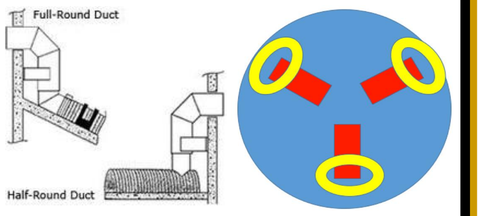
1. Review
2. Technology evaluation
3. General recommendations

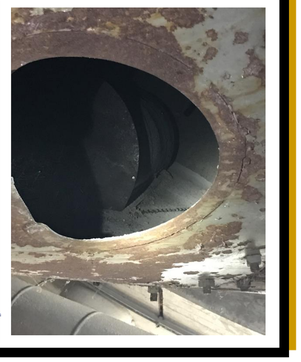
Constraints/Requirements

- No entry
- Food grade materials
- No additional equipment
- Cannot alter grain conditions
- Determine causes
- Hopper bottom bins

Alternative Solutions/Evaluations

- Slick coating
  - No real results
  - Not food grade
- Redesign of aeration tubes
  - Companies have nothing new
- Air whip
  - Not cost affective
  - Not efficient





Data

The most valuable data collected came from our slick bare metal versus a non-slick coated metal which would represent the rusty conditions of a hopper. While grain flow yielded no real results, other data showed that on our stand it held close to 1 oz. more of fines. The stand is roughly 12 sqft. When this is calculated to compare to the sqft. of the hopper, each 22 ft. hopper would hold 5 lbs. of fines.

Surfaces	Slide Area (Sqft)	Average Fine Build-up (g)	Bin Area (Sqft)	Average Fine Build-up/Bin (lbs)
Bare Metal	12	21.3	2322	9.1
Rusted Metal	12	49.6	2322	21.16

Final Recommendations

1. Remove damaged aeration tube caps
   - Replace with redesigned caps that provide better flow and structural integrity
2. Place hopper bottoms on maintenance schedule
   - Install all new metal hopper
   - Sandblast rust and grime to provide a new slick surface

Economic Analysis

Method	Cost/Bin	Cost/Beech Grove Facility
EZ Slide	$210	$44,730
Slip Plate	$330	$70,290
New Steel	$15,000	$3,195,000
Concrete Reslick	$20,000	$4,260,000
Whip Clean-out*		
Low	$1,800	$383,400
High	$5,400	$1,150,200

*5 Day Period, 5-15 Bins

Impact/Sustainability

This project provided a couple of different outcomes. The first being that a slick coating has almost no affect on the grain. The redesign of the aeration tube caps is one solution for stuck grain. The other solution would be to put the grain bin hoppers on a maintenance schedule. This could help fines from sticking and also prevent further buildups.

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