Background

Commercial broiler chicken farms utilize automated feeding systems to deliver feed to the birds. The feeding system is supplied by either two or three external feed storage bins. Feed truck drivers fill the bins of either system in random order, often with varying types of feed. Starter feed is needed first for a flock; feed will then transition into both grower and finisher feed. The bin with starter feed supplies the auger conveyance system until empty. Subsequent bins are opened as needed depending on the nutrient requirements of the current flock. Feed bin transition requires a manual closing and opening of the bins by the grower. If not done immediately, a lapse in feeding of the broilers occurs, resulting in a subsequent decrease in profit for the farmers. Our goal is to detect when the first three of the tanks is empty and initiate the start of a mechanism that will automate movement of the slid gates using the house controller. The design will take into account several constraints, including user-friendliness, compatibility with existing system, safety regulations and cost-effectiveness.

Objectives

- Mechanical: Design a cost-effective, weather durable mechanism to be implemented in a commercial broiler facility’s feed storage system that will automatically close the slide gate of three bulk feed bins while simultaneously opening the gate of the adjacent bin.
- Control Logic: Create the framework to interface with the current climate control system, that will initiate the start of the mechanism when the first feed bin is emptied, continuing through two subsequent bins, while also altering the controller when all feed bins are empty.

Design Analysis

The feed bins observed during the visit to King Trail farm could hold approximately 105,000 lbs of feed in three bins being shared between two houses (35,000 lbs/bin). Such a large amount of feed will produce a significant downward force on the slide gate. Some of this force is mitigated by the formation of the cone, however, there still is a substantial force that will impede the opening of the slide gate. An analysis of the downward force on the gate and the force required to open the gate was conducted utilizing the Janssen equation. It was calculated that a downward force of 289 lbs was enacted on the slide gate. From this, a linear force of 145 lbs was determined to be needed to open and close the slide gate of a feed bin filled to maximum capacity.

Standards

- Safety for Farmstead Equipment (ANSI/ASAE S354.5 JAN2006 (R2011))
- Guarding for Agricultural Equipment (S493.1 JUL2003 (R2012)).

Cost Estimate Per Bin

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit Cost</th>
<th># of Units</th>
<th>Subtotals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linear Actuator</td>
<td>$56</td>
<td>1</td>
<td>$56</td>
</tr>
<tr>
<td>Proximity Sensor</td>
<td>$30</td>
<td>1</td>
<td>$30</td>
</tr>
<tr>
<td>Wiring Kit</td>
<td>$12</td>
<td>1</td>
<td>$12</td>
</tr>
<tr>
<td>11 Ga. Galvanized Steel Sheet Metal (4’x2’)</td>
<td>$18</td>
<td>1</td>
<td>$18</td>
</tr>
<tr>
<td>Misc Hardware</td>
<td>$3</td>
<td>1</td>
<td>$3</td>
</tr>
<tr>
<td>Manufacturing Cost</td>
<td>$60</td>
<td>1</td>
<td>$60</td>
</tr>
<tr>
<td><strong>TOTAL COST</strong></td>
<td></td>
<td></td>
<td><strong>$174</strong></td>
</tr>
</tbody>
</table>

Environmental Concerns:
- High air particulate content
- Design fits under existing cover
- Sheet metal bends form shielding around actuator and other components
- High moisture levels- corrosion of metal components
- Galvanized sheet metal to resist rust
- Actuator selected for optimal durability

Space constraints:
- Need about 24 inches of clearance around bin for mounting, movement, and servicing
- Auger housing may not drop more than one inch to allow for bin cleanout by feed truck

Cost Estimate Per Bin

Slide Gate Design

**Cumberland’s Proximity Sensor**

Proximity sensor adapted from Cumberland’s Flow Hammer used as method of reading and reacting to feed flow out of bins.

**Linear Actuator**

Actuator positioned in reverse in order to conserve space, and allow the line of motion extends away from the bin.

**Slotted link mechanism connecting slide to actuator**

The yoke mechanism will translate force from the linear actuator into a parallel pull on the slide.

**Sheet metal component with slide guides and actuator mounts**

The unit will be formed out of galvanized steel sheet metal and positioned between the black plastic transition piece at the bottom of the bin’s plastic boot and the auger housing at the bottom of the bin.

Summary

A series of logic statements were generated in order to provide a methodology to be later programmed into Cumberland’s Edge Climate Control System. Farmer’s will be able to select a sequence of bins to be opened based on the current feed locations at that particular house.

Acknowledgements

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- Mr. Adam Weiss, Cumberland

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