4-28-2017

Grain Dryer Testing Facility

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Problem Statement

Our client, Dr. Maier, is a post-harvest engineer at Iowa State University. He presented our group with the problem that industry currently doesn't have a third party facility that is able to test their grain dryers so this can lead to inconsistent results. There are tests being done on companies dryers, but it is by themselves and under their own procedure. The problem that arises from this is that each company is able to skew their data by their tests. Companies would like to be able to compare their dryers to other companies fairly to see the results. We have not found anyone who does such a procedure so this would be the first of its kind.

Disciplines

Bioresource and Agricultural Engineering | Industrial Technology

Authors

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Department of Agricultural and Biosystems Engineering (ABE)

TSM 416 Technology Capstone Project

Grain Dryer Testing Facility

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Client: Iowa State University, 3325 Elings Hall, Ames, IA 50011

- Contact: Dr. Dirk Maier, Professor, dmaier@iastate.edu, 515-294-0140

1 PROBLEM STATEMENT

The industry does not currently have a third party facility in which they can test their grain dryers, leading to inconsistent statistics. Currently, there is no ASABE standard for grain dryer testing.

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Business Case Statement

A. There is no industry standard for grain dryer testing.
B. This is a problem across the whole grain dryer industry.
C. The problem occurs when marketing and making decisions on the purchase of a product.

D. By solving this issue it benefits the farmer in that they will be comparing apples to apples. It benefits manufacturers in that they can provide reliable side by side comparison data.
E. Farmers care about this because they stake money in the situation. The industry cares as they can then back the information they provide to the customers.

2 GOAL STATEMENT

A. The root cause of the problem is that no one has defined a standard procedure in which all companies must use.
B. A standard will be in place for use by all manufacturers of horizontal grain dryers. The layout and equipment required for testing will be determined.
C.
    - Ambient air temperature, humidity, wind speed and direction, electrical usage, fuel consumption and incoming and outgoing grain quality and moisture will be recorded during tests of dryers.
    - Test results and testing procedures will standardize how manufacturers communicate the capabilities of their dryers.
    - Standardized testing of dryers will allow consumers to make a more accurate comparison between products from different manufacturers.
    - Test facility design and test procedures will aid in the creation of a grain dryer testing facility.

- **Main Objective(s) and Specific Objectives**
    - **The main objective is to design a facility to test horizontal grain dryers. Specific objectives include***:*
    - (1) Design the layout for a testing facility in which these parameters of a grain dryer can be consistently tested:
        - Moisture removal
        - Electric energy usage
        - Gas energy usage
        - Grain quality
        - Capacity
    - (2) Develop an industry standard for testing horizontal continuous flow grain dryers.
- **Rationale**
    - Industry standard developed for possible use in industry.
    - Effective comparison of horizontal grain dryers.

3 PROJECT PLAN/OUTLINE

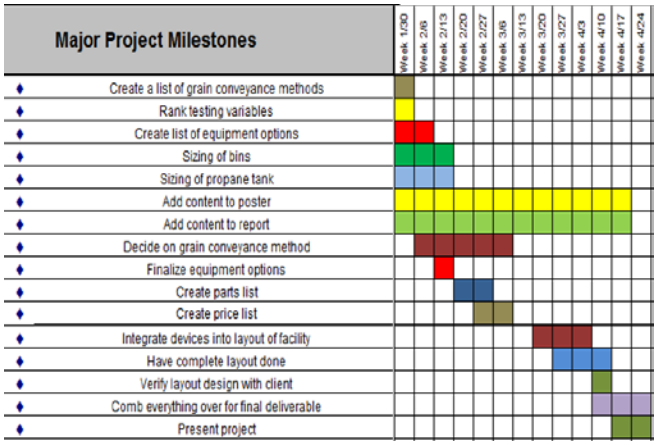
A. Methods/Approach

- **Reference Material(s)**
    - Sukup, Brock, and GSI sales brochures
    - *Managing Grain After Harvest* textbook written by Dr. Carl Bern, Dr. Charles Hurburgh, and Dr. Thomas Brumm
    - *Grain Drying Systems* research article written by Dr. Dirk Maier
    - USDA Grain Standards

    - ISO 11520-1 manual
- **Data collection**:
    - Contacted dryer manufacturing companies to gather information about how they test their dryers. Asked about what dryers they would be willing to bring to the facility to test and the specs of these dryers.
    - Worked closely with Dr. Maier and other grain quality experts.
    - Utilized textbooks, journal articles, and other fact-based references/resources.
- **Skills**:
    - Methods in which manufacturers currently test their horizontal grain dryers
    - Theoretical equations to base efficiencies off of.
    - Classes that we have taken or will be taking that aided in the process of this project are: TSM 363, TSM 116, TSM 216, TSM 210, and TSM 465
- **Solutions**: Our team developed proposed solutions by conducting research about grain dryer testing and working closely with our client to understand their needs and expectations.
    - We measured which solution or parts of the proposed solutions are better based on price, size, and client needs.
    - We kept cost and size restrictions in mind to evaluate which solutions and parts of solutions were better.
    - All proposed solutions are consistent with objectives and the scope.
    - All proposed solutions will meet client expectations.
- **Organization:** Our team met with our representative every 3-4 weeks in person or via email and Skype. Our client was out of the country often for work so we also worked closely with Sam Cook and our faculty mentor Dr. Brumm.
    - We distributed work evenly among team members and assigned tasks best related to each individual's strengths.
    - Major milestones included completing the CAD drawing of our design, developing a Standard Operating Procedure for the test facility, and developing a list of parts with their approximate cost.
    - We responded to setbacks by discussing with the team and our sponsor the best way to continue moving the project forward in the best possible way.

B. Results/Deliverables and Timeline

- Developed a list of equipment options and advised equipment to be used in the facility.
- Designed a layout for the facility that incorporated all of the needed features for testing.
- Created a standard to be followed during testing of the grain dryers.



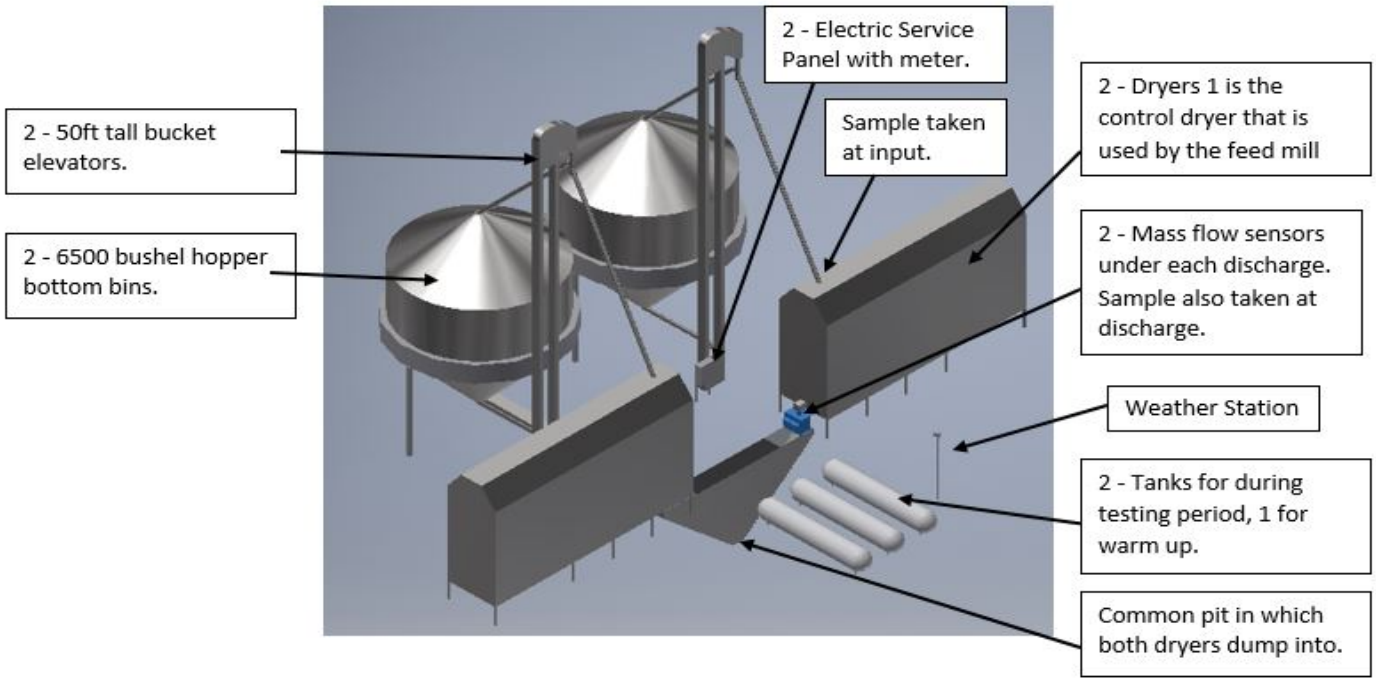
4 BROADER OPPORTUNITY STATEMENT

A. The appeal of this project is the ability to obtain accurate side by side comparisons of horizontal grain dryers from different companies.
B. This project could have an effect on improving industry safety and on environmental concerns in various ways.
C. The test facility will be designed specifically for testing and comparing horizontal grain dryers and will most likely not impact other industries.
D. The use of our solution is entirely within the industry of grain handling.
E. This project could possibly create a focus in industry on efficiencies of other agricultural processes driving the creation of other test facilities and standards.
F. By creating these standards and a facility in which a company's horizontal grain dryers can be fairly compared this may aid them in marketing as it will resolve any ambiguity in the process.

5 PROJECT SCOPE

A. Designing a test facility for horizontal grain dryers and developing a test procedure.
B. Building and operating the test facility as well as testing other non-horizontal types of dryers (tower, bin, etc.) would be outside of our team's boundaries.
C. We are not testing tower grain dryers because they are not easily transportable for companies to bring to the proposed testing facility at Iowa State University.

6 GRAPHICAL ABSTRACT



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Acknowledgements

Dr. Dirk Maier – Project Client

Dr. Tom Brumm – ABE Faculty Mentor

Sam Cook – ABE Research Asst. to Dr. Maier

John Haughery – ABE Lecturer

Casey Heilskov – Sukup Manufacturing

Gary Woodruff – GSI Grain Systems

James Williams - Brock Grain Systems

Dryer Information

From the companies that we contacted here are the models of dryers in which they said they would be willing to bring to such a testing facility: Sukup - T283, Brock - SQ40 Super B, GSI - 1200 H series. The dimensions of these dryers are:

- Sukup T283
  - L - 37’3”
  - W - 7’11”
  - H - 14’7”
- Brock SQ40 Super B
  - L - 52’8”
  - W - 7’4”
  - H - 14’2”
- GSI 1200 H Series
  - L - 35’10”
  - W - 8’8”
  - H - 21’2”

Testing Equipment

Moisture Analysis

	Perten 5200 AM (Recommended)	Dickey-John GAC 2500-UGMA
Price	$5,400	$5,700
Certification	NTEP	NTEP
Sample Temperature	32°F to 160°F	-4°F to 113°F
Frequency	150 MHz	149 MHz
Moisture Range	8%-46%	5%-45%
Analysis Time	10 seconds	10 seconds
Memory Storage	300,000 samples	3,000 samples

Electrical Consumption

	Schneider Electric EM3555A (Recommended)	Accuenergy Acuvim-II
Price	$614	$595
Capability 1	Measures kWh	Measures kWh
Capability 2	Data transferability	Data transferability
Capability 3	Peak demand times given	Peak demand times given

Grain Dryer Capacity

	Eastern Instruments CentriFlow CFM-24 Type II	Eastern Instruments CentriFlow BWS-24 Type II (Recommended)	Monitor Technologies QuantiMass
Price	$20,340	$10,600	$12,500
Accuracy	±0.25% - 0.5%	±1.00% - 2.00%	1.00% - 3.00%
Repeatability	±0.10% - 0.25%	±0.25% - 0.50%	Not specified

Recommended Flow Meter

Grain Quality Measurement

	MCI Kicker (Recommended)	Carter Day Dockage Tester
Price	$6,700	$13,000
Attribute 1	Approved for commercial use	Approved for commercial use
Attribute 2	Uniformly separates samples	Uniformly separates samples
Attribute 3	Fast, quiet, and vibration-free	

Grain Quality Measurement Equipment includes a Boerner Divider ($1,750) and a Seedburo 900AG dockage scale ($1,595)

Atmospheric Condition Monitoring

	Davis Instruments 6153
Price	$1,150
Attribute 1	Ethernet Data Logger
Attribute 2	Measures all necessary parameters (temperature, wind speed/direction, barometric pressure, relative humidity)
Attribute 3	+/- 1% accuracy