IOWA STATE UNIVERSITY

Department of Agricultural and Biosystems Engineering (ABE)

TSM 416 Technology Capstone Project

Testing Poultry Dust Mitigation Practices

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1 PROBLEM STATEMENT

Problem Statement

- Cage-free chicken farms are prone to significant amounts of dust in the air due to the disturbance of the litter (bedding) on the ground. We needed to develop a physical test system and Standard Operating Procedure (SOP) that is able to capture and record dust samples. So the client is able to test different litter management practices, vegetable oil, for example, to minimize the amount of dust airborne in cage-free chicken farms.
- The ideal amount of litter management treatment is unknown. This must be solved to help lower the amount of dust that is airborne in cage-free chicken farms. A high amount of dust in the area from the disturbed bedding will cause the air quality in the barn to be very poor. High dust concentrations result in harmful effects on not only the health of chicken production employees but also the birds.
- Many poultry production companies over the United States are implementing different litter management practices to try and reduce the airborne dust due to the ban of battery cages for raising poultry in some states. Michigan, Ohio, Washington, and California have bans on battery cages. This results in many more poultry farms in the states listed above to turning to cage-free farms.

Business Case Statement

- The airborne dust problem is very common in the cage-free farms due to the chickens constantly disturbing the litter (bedding). This results in dust being stirred up, and airborne, which then production employees and the poultry will breathe in. Correct litter management practices need to be discovered and implemented to protect the air quality within barns for production employees, as well as the animals. This problem can be addressed by creating a test solution for different litter management practices to then reduce the overall airborne dust.

2 MAIN OBJECTIVE

Main Objective and Specific Objectives

- The main objective is to develop a physical test system and Standard Operating Procedure (SOP), that is able to capture and record dust samples, so the client is able to test different litter management practices to minimize the amount of dust in the air at cage-free chicken farms.
- **Specific objectives include***:*
  - *i)* Designing a test system using a concrete mixer to simulate the chickens walking on the chicken litter that captures dust sample data.
  - *ii)* Deliver final project Information document to the client.
  - *iii)* Developing an SOP for the project.
  - *iv)* Develop a testing procedure to conduct the same process over and over using many different aggregates such as concrete mix or chicken litter.
  - *v)* There are not many injury-prone areas associated with this project. While using the cement mixer, ensuring you have no loose clothing on to make sure the test is able to be done safely. Overall the major injury-prone area is the health hazards that are associated with breathing in high amounts of dust in this cage-free chicken farms.

Rationale

- When the test system is completed, the client will be able to also test different litter management solutions to low the airborne dust in poultry farms. This litter management practices will then be able to be implemented in various poultry farms in the area.
- *Example 1* – Reducing the overall airborne dust by implementing litter management practices by 20%
- *Example 2* – Reduce the health risks involved by breathing in the dust by 25%.

Project Scope

- The boundaries of this project have been the same throughout the whole project. The project scope was driven by the client due to us being on a small timeframe.

3 METHODS/APPROACH

Reference Material(s):

- Specific materials found by the team to help guide us through the project were various verified poultry sites online.

Skills:

- Prior knowledge of having been inside a chicken farm was used to help understand the overall scope of this project. Also, using videos online to see what a cage-free chicken farm was used to get us also a better understanding of the project.

Organization:

- Our team met 3x times a week. We would communicate with Tim Shepherd, our sponsor, usually every day while we would work on the project.
- Teamwork was split up evenly between Ben & Grant. Each team member would be working on different tasks at the same time to ensure efficiency. Ben & Grant communicated daily to ensure we were both on the same page.
- Major milestones involved with this project are the creation of the physical test system, creating an SOP to ensure the same process can be repeated, and lastly, testing using concrete and also chicken litter.

4 RESULTS

Results/Deliverables

- The main deliverables of this project are creating the plan for a test system, developing an SOP for testing along with all other materials for testing such as templates for data collection, and PID (project information document).
- While access was still available to the creation of the planned test system went very well. The team collected all the needed information to develop and create the plan for a teat system to create repeatable dust samples with an array of aggregates and aggregate treatments.

Below is the procedure for testing and collection of data.

Leak Test Procedure

Prior to the start of testing, you must check for leaks in the system.

1. Before installing the filter papers into filter housing weigh and record how much the filter papers weigh prior to testing.
    a. After testing, you will subtract this weight from the dirty filter weight and come out with the amount of dust collected.
    b. Once filters are installed, continue with the leak test procedure.
2. Start by removing the plexiglass lid from the drum of the cement mixer.
    a. Remove the 4 long bolts to take off the plexiglass lid.
3. Individually put your finger over each of the 3 hoses in the lid to plug the airflow.

   a. Ideally, when the airflow is stopped, the flow meter that is attached will drop to 0, indicating that there are not any leaks.
   b. If there is still flow being registered on the flowmeter, troubleshoot the connections in the hose and retest until all the leaks are gone.
4. After confirming the systems are leak-free, move on to the testing procedure below.

Testing Procedure

1. Measure out 500g of aggregate for testing.
   a. Concrete is to be used for initial testing.
   b. After the testing procedure is verified, chicken litter can be used.
2. Pour 500g of aggregate into the cement mixer.
3. Fasten plexiglass lid to wooden c-clamp on the cement mixer using the four long bolts.
   a. Ensure the nuts are tight on the bolts to make sure there is no leakage of "dust" during the initial testing.
4. Before installing the filter papers into filter housings, weigh and record how much the filter papers weigh prior to testing.
   a. After testing, subtract this weight from the dirty filter weight and come out with the amount of dust collected.
5. Turn on the vacuum pump, and set the flow meter attached to the vacuum pump to 3 CFM and record the flow rate.
6. Turn on the concrete mixer.
   a. Allow the mixer to run for a minimum of 2 hours; this will ensure agitation inside will be allowed to produce a usable amount of dust.
   b. Run the mixer in 2-hour intervals. For example, 2 hours, 4 hours, 6 hours. This will ensure the collection of accurate data samples.
7. Record the airflow rate while the machine is running.
8. Before leaving the laboratory for testing, ensure there are no leaks around the fittings on the filters, each flow meter attached to the filters, the manifold, and lastly, the vacuum pump.
   a. If there are any air leaks, turn the system off, and fix them to ensure we can create accurate dust samples.
9. If there are no air leaks, continue to let the system run for either 2, 4, or 6 hours.
10. Record the flowrate from the master flow meter.
11. After the system has run for the desired time, turn the cement mixer off.
12. Turn off the vacuum pump.
13. Carefully unscrew the top portion of the 3 filters.
14. With the laboratory scale close by, with tweezers, grab the paper filters and weigh them from each filter. Clearly, labeling which filters the paper filter came from due to the different factors associated with the flow meter when testing.
15. Compare the weight of the paper filter after testing to the weight of the paper filter before testing. Record this data as the weights are very important.

   a. If chicken litter was used, compare the dust results on the paper filter after testing to the paper filter before testing.
16. Remove the plexiglass lid by taking out the long bolts.
17. Dump the remaining aggregate (concrete mix, or chicken litter) inside into a bucket to be disposed of.
18. If you are switching between concrete mix and chicken litter, wash the cement mixer drum out with water before switching between the two. This is to ensure accurate data is formed when collecting the dust samples.
19. Replace the 3 filters with new paper filters for testing.
20. Repeat steps above starting at step 1, regardless if using a concrete mix or different ratios of chicken litter.

Flush Procedure

1. When switching between aggregates, wash the cement mixer drum out with water.
   a. While water is still in the drum, turn on and spin to ensure the drum gets cleaned thoroughly.
2. Drain the water out and allow the drum to dry completely before starting another test.
3. Individually clean each hose in the system with compressed air and ensure there is no aggregate left in it.
4. Reconnect the system and make sure to check leaks before starting a new test. (See Leak Test Procedure)

Weighing Procedure

1. Before each weighing session, ensure the scale is zeroed and calibrated.
2. Handle the filter carefully without touching it with your fingers.
3. Open the draft shields on the scale.
4. Place the filter onto the center of the scale and wait for the scale to stabilize.
5. Record the weight and which tube the filter came from.
6. Remove from scale and dispose of the used filter.

Below is the Filter Data Excel Template to be used for data collection.

Test Number	Aggregate	Treatment	Hours Processed	Pre-Test Master Flow Meter Reading	Post-Test Master Flow Meter Reading	Pre-Test Flow Meter #1 Reading	Post-Test Flow Meter #1 Reading	Pre-Test Flow Meter #2 Reading	Post-Test Flow Meter #2 Reading	Pre-Test Flow Meter #3 Reading	Post-Test Flow Meter #3 Reading
1	Concrete	NA	2	3	2.3	3	2	2	3	4	1
2											

Test Number	Pre-Weight #1	Post-Weight #1	Pre-Weight #2	Post-Weight #2	Pre-Weight #3	Post-Weight #2	Weight #1	Weight #2	Weight #3	Test Average Weight	Notes
1	0.002	0.0067	0.0021	0.007	0.0022	0.0073	0.0047	0.0049	0.0051	0.00490	EXAMPLE
2										#DIV/0!	

Recommendations

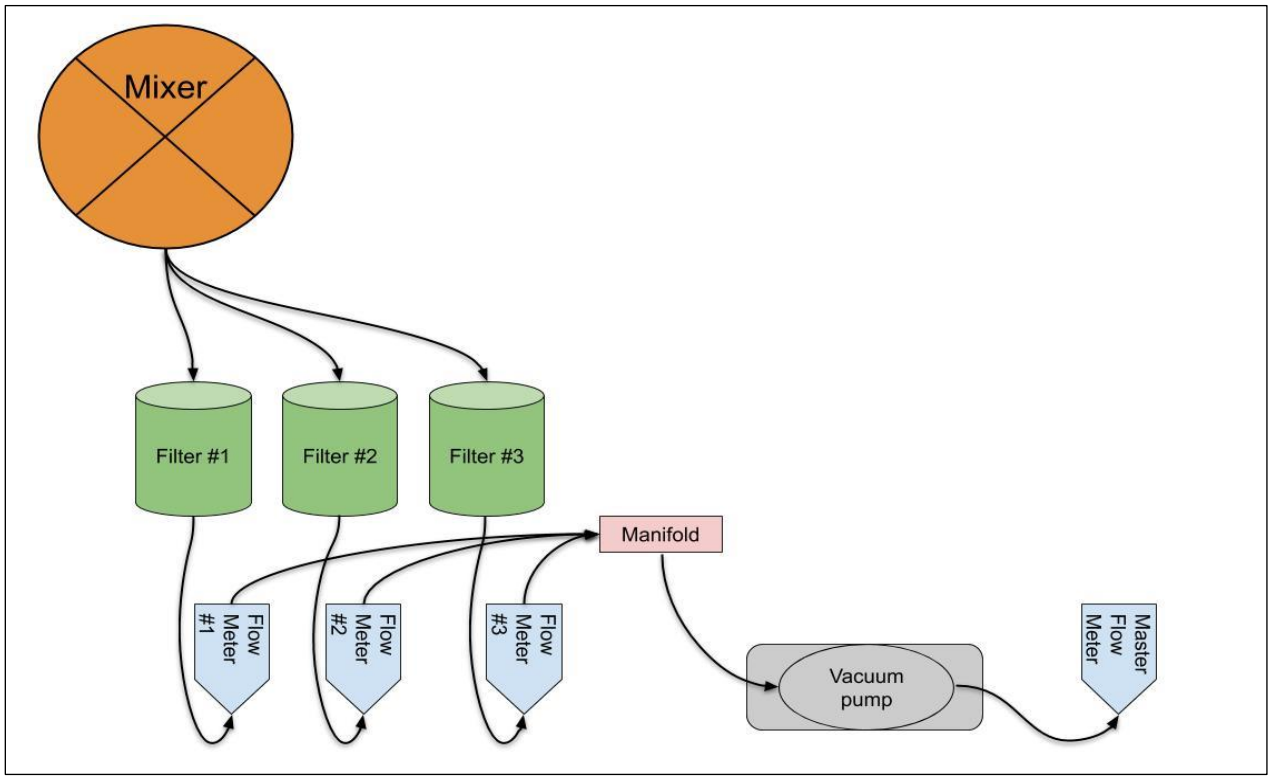
- Conduct samples first with the only concrete mix as the aggregate to establish control. After control and a baseline, a number have been set for how much dust is collected under no treatment then add desired vegetable oil to test if that will reduce dust creation. After multiple tests have been conducted and credible evidence shows that dust reduction is happening with treatment, then repeat the same tests to prove with chicken litter as the aggregate.

5 BROADER OPPORTUNITY STATEMENT

- This project is easily able to be understood by the average person. It is a reality simple project due to creating a test system to simulate the dust in the air in cage-free chicken farms.
- This project directly address the health concerns that are involved with working in cage-free chicken farms that have a low air quality.
- There are many people who this project directly involves. If you are any type of cage-free poultry farmer, you have some type of litter or bedding on the ground for the animals. By us conducting tests to see what litter management practices work the best, we will be able to directly compare and communicate to other poultry farmers the benefit of using different litter management practices.
- Any type of poultry farmer that involved cage-free will be able to implement the different litter management practices to improve their own air quality in their barns.
- The solution in the long term should help lower costs of chicken litter due to less being disturbed and airborne. Better litter management practices will keep the litter on the ground, and out of the air. Resulting in better air quality.

6 GRAPHICAL ABSTRACT

Below is the schematic for the project, which is referenced during the entire project. This schematic doubled as our PID for our project sponsor. All names are referenced in the SOP and Data Template.



7 REFERENCES

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