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# *Factors Affecting Pre-filter Loading and Strategies to Manage Excessive Loading*

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**ABSTRACT.** Ventilation air filtration is becoming a popular method to control airborne transmission of diseases on commercial sow farms. For example, air filtration can reduce the frequency of airborne outbreaks of porcine reproductive and respiratory syndrome virus (PRRSV). The capital investment is justified on the basis of diseases losses avoided, but better data on filter lifespan is needed to give producers a more complete understanding of all costs related to air filtration. In Objective 1 a 6-month (May-to-November) intensive study was done on commercial sow farms to determine factors affecting pre-filter lifespan. In Objective 2, a study into methods to prolong pre-filter life span was done under high dust loading conditions (row crop harvest season) on a gilt-development (GDU) farm. The filter brand, correct installation, and three factors related to the filter bank (north or south facing, driveway side, and what the bank faced) were collected along with filter weight and airflow using mobile air filter testing (MAFT) laboratory for random sub-sample from each filter bank on each farm in the study. For Objective 1, the filter brand and correct installation had significant impacts on lifespan. The worst case factors for filter lifespan were facing a barn exhaust, being on the driveway side of the barn and facing north. For Objective 2, the filter prolonging study found that the treatment methods improved filter lifespan and that the extreme loading scenario was significantly worse for filter lifespan than the conditions on the sow farms in this study. The various effects on pre-filter lifespan and improving estimations for filter lifespan is a key step to understanding the operating costs of air filter systems on commercial swine farms.

***Keywords.*** *air filter, biosecurity, filter lifespan, filter loading, swine*

# Introduction

The use of air filters on swine and poultry farms has been shown to prevent the spread of airborne pathogens (Burmester & Witter, 1972; Dee, Batista, Deen, & Pijoan, 2005). As other sources of disease transmission into swine farms have been addressed with increasingly stringent bio-security practices, the aerosol route has come under greater scrutiny. With the implementation of air filters on sow farms, swine producers are able to see a return on investment for the initial capital investment by reducing the frequency of Porcine Reproductive and Respiratory Syndrome Virus (PRRSV) outbreaks (Alonso, Davies, Polson, Dee, & Lazarus, 2013).

As with any type of ventilation system that utilizes air filters, there is a capital cost of the system and an operational cost. For swine producers there is minimal data available regarding the operational costs associated with implementing air filtration. Typically, the largest component of the operational cost is centered around the filter lifespan in the system. The operational differences between the environments that air filters are in on a swine farm compared to a commercial Heating, Ventilation, and Air Conditioning (HVAC) system are too different to utilize the baseline for filter lifespan.

. The objectives of this study were (1) to determine factors affecting pre-filter lifespan via a 6-month (May-to-November) intensive study on commercial sow farms and (2) to explore methods to prolong pre-filter life span on a gilt-development (GDU) farm under high dust loading conditions (row crop harvest season).

# Site Descriptions

For Objectives one, eight commercial sow farms were utilized. Each site had six barns, four breeding-gestation, and two farrowing that utilized a positive pressure ventilation with filtration system. The description of the positive pressure ventilation system was noted in Ramirez, et al., 2016. All eight sites were located in central Iowa. The orientation of the dormers on the barns, driveway side, and farm layout varied slightly site to site. For Objective two, a three barn gilt-development unit was utilized that was in close proximity to a grain handling facility. All three barns utilized a positive pressure ventilation with filtration system. Only the two identical barns on the site were utilized in the study. The two barns had air intakes on the east and west ends of the barns. On each barn a control treatment and a test material, either a 3-D screen or a fiberglass media, was randomly assigned to each air intake such that each barn had one control and one of the two treatments. The test materials were installed on the downstream side of the cool cells in the air intakes.

# Filter Testing

For both objectives, quasi-random sampling was used with a sample size of 5.5% of all filters in the specific filter bank. For Objectives one, a minimum sample spacing of four filters between samples was utilized to ensure that independent samples were collected. For Objective two,. no minimum spacing was followed as the airflow patterns were unknown for the specific filter bank configuration. A filter resistance test (airflow at a given differential pressure) was performed on the pre-filters in the Mobile Air Filter Testing Laboratory (MAFT) with a new v-bank filter in series. Each filter utilized in the study was tested using MAFT for a pre-test, then reinstalled in the same location and tested again for a post test at the end of the study period. Specifics of MAFT's design, uncertainty, and performance can be found in (Smith et al., 2019). Objective one was tested in summer 2017 to fall 2017 and objective 2 was tested during row crop harvest season 2017. Filter characteristics and the site layout factors were recorded at the time of the pre-test.

# Results and Discussion

A total of 841 pre-filters were tested for objectives one, and a total of 100 pre-filters were tested for objective two. Figure 1 shows the airflow reduction observed for two of the eight sow farms in the study. Across the eight sow farms the average observed airflow reduction was 16.67 L $min^{-1}$ $day^{-1}$ ± 0.57. The factors that were observed to have the largest impact on airflow reduction was a dormer facing the exhaust of an adjacent barn and the least impactful was a dormer facing a field and railroad. The dormer on the driveway side was also shown to have a negative impact compared to placement on the non-driveway side. A difference between the two filter brands was observed and the correct installation of the pre-filters did have a positive impact on the airflow reduction. The dormer orientation had an impact on the airflow reduction rate, with the north facing dormers having a higher reduction rate. For objective two, the two test materials used were both shown to reduce the airflow reduction rate during the row crop harvest, but no difference between the two materials was noted.

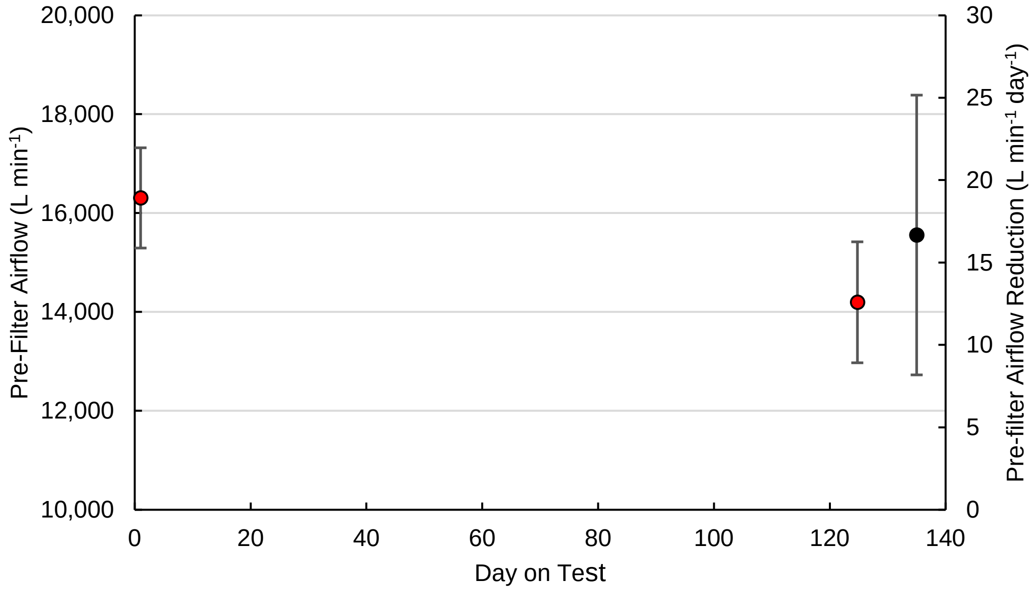


*Figure 1 Average pre-filter airflow change from pre-test to post-test, red circles, error bars represent 1 standard deviation of all sow farms observed. On the secondary Y axis the average pre-filter airflow reduction per day, black circle, the error bars represent one standard deviation of all sow farms observed. Note the days on the airflow reduction per day are arbitrary on this graph.*

# Conclusions

An airflow reduction rate for pre-filters on commercial sow farms was observed at 16.67 L $min^{-1}$ $day^{-1}$ ± 0.57. Key factors that negatively impact pre-filter airflow reduction were identified. These included placement of the dormer facing the adjacent barn's exhaust, being on the driveway side, and facing north. The filter brand and installing the pre-filter according to the manufacturer's recommendations also impacted the filter's airflow reduction. Adding an additional filtration material was shown to reduce the airflow reduction rate on a site with high dust loading potential during row crop harvest season. Further testing and monitoring is needed to observe the airflow reduction rate throughout the year as cool cell operation can have an impact on filter performance and the variable airflow rate based on ambient conditions. This study highlights the key areas for producers to address to maximize the pre-filter lifespan and a few methods for doing so with additional test materials. An economic analysis of the operating cost of the filtration system needs to be conducted to determine the financial feasibility of adding mitigation strategies on farm to maximize filter lifespan.

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