Can Trailer Design Effectively Reduce Disease Transmission?

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Addressing an Industry Need

In response to an industry need for a livestock vehicle that addresses both increased animal welfare and biosecurity during transport, a prototype air-filtered trailer was designed and assembled. The project set out to select the best possible option for a swine transport trailer which reduces or prevents the risk of airborne disease transmission and at the same time address issues commonly encountered on existing trailer designs such as animal welfare, ease of maintenance as well as trucker/worker well-being. An industry questionnaire gathered input on observed strengths and deficiencies of the conventional commercial swine transport trailers and was distributed to a number of stakeholders involved in pig transportation and researchers. Additionally, desired features and preferences for an improved swine transport trailer were gathered and formed the basis for the initial new trailer design. Multiple design configurations were narrowed down using computer simulation with the most promising trailer design being developed as a prototype.

Trailer Design

The final design featured a transport trailer with two separate compartments: front compartment that houses generator set, a bank of 6 air filters, ventilation controller, supplemental heater, and two axial fans. The livestock compartment (Figure 1) has solid walls, in contrast to conventional livestock trailers where side vents are present throughout the entire length of the trailer. It has two straight decks each divided by a gate into two compartments (front and rear). Both bottom and upper decks are 3’5” in height. The middle portion of the floor of the upper deck is hinged and can be lifted up to allow easier loading, unloading or other activities (i.e., trailer cleaning, washing, inspection, etc.) in the bottom deck. Similarly, the middle portion of the trailer roof is hinged for the same purpose in the upper deck. Additionally, pneumatic cylinders are installed on these hinged panels of floor and roof for easier lifting and closing of these movable parts. To address animal handling and welfare issues arising from use of ramps in the conventional livestock trailer, a 1000-kg capacity hydraulic loading platform was added in the prototype trailer.

Trailer Efficiency

Based on this design, the prototype trailer was assembled and evaluation of the effectiveness of the installed air filtration system (MERV-8 pre-filter and MERV-16 main filter) showed overall reduction of 96.9% in concentration of aerosolized model virus (bacteriophage Phi X174) inside the animal compartment relative to upstream of the filter (Figure 2). In addition, over two monitoring trips with pigs loaded, the trailer showed the mechanical ventilation system was able to maintain the desired thermal conditions within the animal compartment. Supplemental heating unit helped to ensure that the temperature in the animal compartment did not go lower than 10°C during the trips under winter conditions. However, events during the trip (slowing down or full stops due to traffic stops) affected environmental conditions inside the trailer, although the desired conditions were quickly restored once the trip resumed - when the mechanical ventilation control system enabled compensation for relative humidity and carbon dioxide levels in the animal compartment in addition to the conventional temperature-based control.

Cost Analysis

Cost analysis of the air-filtered trailer (prototype) including equipment, installation, operational and filter maintenance costs, yielded a payback of 2.10 years assuming a $5 premium per pig for transporting pigs using an air-filtered trailer. From this first effort on design and development of this new transport trailer, various points for optimization of the prototype have been identified to facilitate continuing work to further improve the efficiency of the trailer and to bring the overall trailer design closer to commercialization.

Next Steps

The next step is to fully gain the confidence of livestock producers to adopt and utilize this design, it is strongly recommended that the air-filtered trailer is ultimately tested against a disease challenge, wherein the performance of the trailer in protecting the animals being transported is assessed when the trailer is actually exposed to conditions known to certainly cause airborne transmission of disease. For more information on this project please visit prairieswine.com.

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Figure 1. Photos of the animal compartment showing (A) its lower and upper decks, (B) hinged roof, (C) gate that partitions each deck into two compartments, (D) air exhaust damper, (E) hydraulic loading platform, (F) hydraulic system showing motor, pump, controller and power supply, and (G) exterior of the assembled compartment.

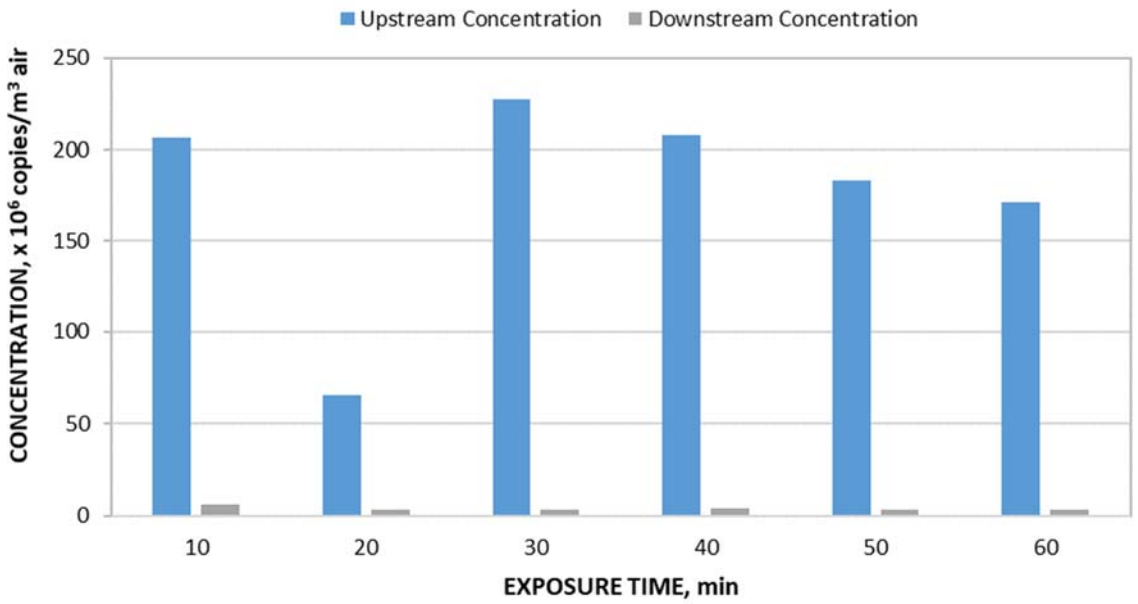

Figure 2. Total bacteriophage Phi X174 (in genome copies/m^3 of air) detected by qPCR. Each bar represents average concentration of the surrogate virus in the air sampled using 37-mm cassettes loaded with polycarbonate filters from four replicate trials.