CONVERTING POULTRY HOUSE EMISSIONS INTO FERTILIZER

A proposal for an affordable and sustainable poultry house improvement that cash flows for the grower.

JUSTIFICATION

SUSTAINABLE POULTRY PRODUCTION is essential to meet consumer demand and protect our domestic food supply.

ENVIRONMENTAL REGULATIONS and mandates are inevitable if the industry is not proactive in addressing emissions issues.

ANIMAL WELFARE demands control of gaseous NH_3 before and during the growout.

TUNNEL VENTILATION provides an opportunity to scrub the centralized exhaust air with minimal modifications to the poultry house.

RIGHT-TO-FARM is challenged by a growing population. For public safety & health concerns, odor control in agricultural operations is essential, including animal rearing, chemical storage, and manure shed facilities. Vegetative environmental buffers (VEB) have been encouraged as one measure to mitigate emissions.

CHESAPEAKE BAY is impacted by gaseous NH_3 and other emissions. SB135 is proposing a tax on emissions.

CLIMATE CHANGE experts call for reductions in PM, gaseous NH_3, CO_2 and other emissions.

FERTILIZER PRICES are rising which makes onsite ammonium sulfate production a cost-effective alternative revenue source for growers.

MULTI-HURDLE INTERVENTIONS on the farm improve broiler health and aid in achieving USDA and HACCP performance standards.

$PM_{2.5}$ REDUCTION is dangerous to human health and can be mitigated by scrubbing the exhaust air from poultry houses.

"Air pollution from farms leads to 17,900 U.S. deaths per year, study finds"

https://www.washingtonpost.com/climate-environment/2021/05/10/farm-pollution-deaths/

Table 1. Average ammonia emissions of 50-day old broiler production (Moore *et al.*, 2008).

Source	g NH_3/bird	g N/bird
In-house losses during flock	28.3	23.3
In-house losses between flock	9.09	7.49
Total	**37.39**	**30.79**

"Ammonia emissions from litter in the house were 37.4 g NH3/bird, which corresponds to 14.5 g/kg bird marketed (50 day old birds). Emissions during storage and after land application were equal to 0.17 and 7.91 g NH3/bird, respectively. The total NH3 emission factor was 45.5 g NH3/bird."

Moore, P. A., Miles, D. M., Burns, R. T., Pote, D. H., & Berg, W. K. (2009). Evaluation of ammonia emissions from broiler litter. In Livestock Environment VIII, 31 August–4 September 2008, Iguassu Falls, Brazil (p. 5). American Society of Agricultural and Biological Engineers.

Table 2. The estimated potential for ammonia capture on a Delmarva chicken farm.

DCA Facts & Figures

570,000,000 chickens/year ÷ 5,036 houses

= 113,185 avg. chickens/house/year

37.39 g NH_3/bird total × 113,185 birds/house/year

= **4.2 tons of NH_3/house/year**

(3.2 tons during the growout, 1.0 ton during layout)

https://www.dcachicken.com/facts/facts-figures.cfm

Fertilizer Production Revenue Estimates

4 metric tons of NH_3 per house/year

Treat exhaust with sulfuric acid

Yield approx. 4 g of ammonium sulfate per 1 g of ammonia

Produce 16 metric tons of ammonium sulfate per house/year

Average bulk price of $628 (USDA AMS, Feb 04, 2022)

$10,048 per house/year

https://mymarketnews.ams.usda.gov/filerepo/sites/default/files/3159/2022-03-11/565327/ams_3159_00107.txt

Fertilizer Production Revenue Estimates

During Layout Only

1 metric ton of NH_3 per house/year (***during layout periods only***)

Treat exhaust with sulfuric acid

Yield approx. 4 g of ammonium sulfate per 1 g of ammonia

Produce 4 metric tons of ammonium sulfate per house/year

Average bulk price of $628 (USDA AMS, Feb 04, 2022)

$2,512 per house/year

https://mymarketnews.ams.usda.gov/filerepo/sites/default/files/3159/2022-03-11/565327/ams_3159_00107.txt

Multi-Hurdle Approach

Wet Scrubber #1

Exhaust air is first scrubbed with water to remove large particles including feathers, dust and dander.

Wet Scrubber #2

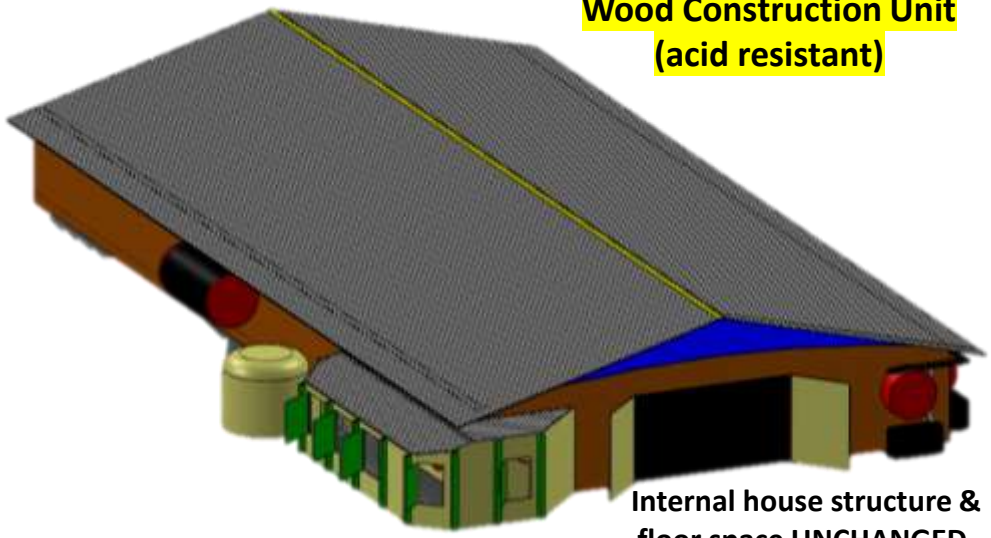
Air passes through a solution of sulfuric acid to remove any gaseous emissions and ammonia is converted to ammonium sulfate. This solution is recycled until it becomes saturated.

Electrostatic Filter #3

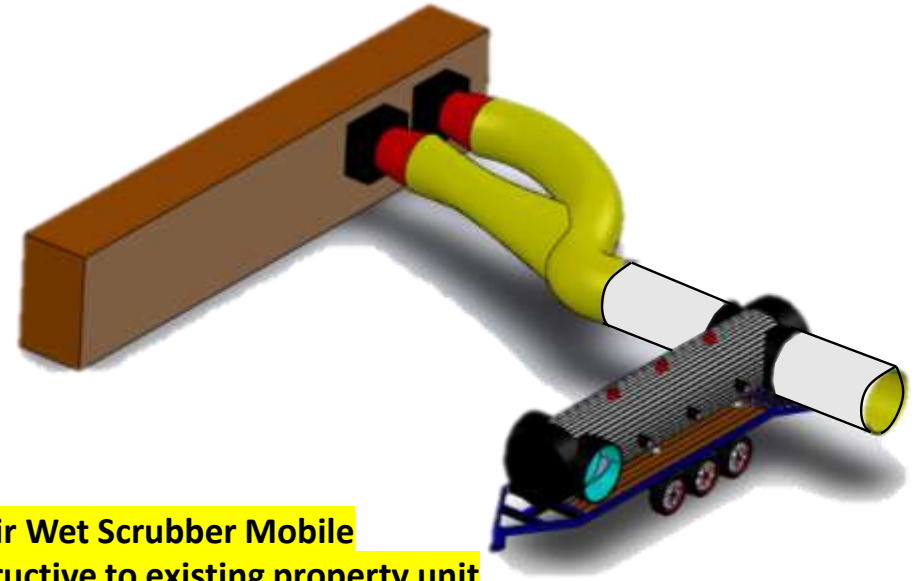
Scrubbed air passes through an electrically charged field to precipitate particles and remaining pollutants.

AIR WET SCRUBBER DELIVERY SYSTEMS: Dust/dander/molds/gaseous NH_3 Collector Degradation System Locations 3-D Schematic

Wood Construction Unit
(acid resistant)



Internal house structure & floor space UNCHANGED.



Air Wet Scrubber Mobile
Non-destructive to existing property unit
(cheapest method of starting unit)

Patent Pending 2022

Potential Grower Business Options

Invest in the Product

- Growers own the system and the fertilizer produced.
- Sell the fertilizer on the open market or back to the service provider.

Subscribe to the Service

- Service provider owns the mobile air-scrubber unit and the fertilizer produced.
- Costs the same of less than litter amendments with improved sustainability

Table 3. Balance equation for ammonia control using a sulfuric acid scrubber.

Chemical Name	**Sulfuric acid**		**Ammonia**		**Ammonium sulfate**
CAS	7664-93-9		7664-41-7		7783-20-2
Molecular Formula	H_2SO_4	+	NH_3	=>	$(NH_4)_2SO_4$
g/mol	98.08		17.031		132.14
mol/reaction	1		2		1
g/reaction	98.08		34.062		132.142