

What we need to know about manure additives — A research-based update

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Ni & Heber (2018) for download

<http://www.extension.purdue.edu/extmedia/ABE/ABE-161-w.pdf>
(*Google search*: purdue extension manure additive)



Agricultural and Biological Engineering
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ABE-161-W

Manure Additives



Manure additives come in different forms.⁴

MANURE MANAGEMENT, TREATMENT, AND UTILIZATION

What We Need to Know about Additive Products for Manure Treatment

Ji-Qin Ni and Albert Heber - Purdue Agricultural and Biological Engineering

A variety of technologies are available for manure management to reduce odor and gas emissions, keep nutrients in manure, and make manure handling easier.

What are manure additives

Manure additives (pit additives) are solid or liquid products added on or in manure to:

- reduce air pollution by reducing releases of ammonia, hydrogen sulfide, and other odorous gases from manure;
- preserve nutrients, usually nitrogen, in manure; and
- reduce solids and liquefy manure for better handling.



Photos from internet

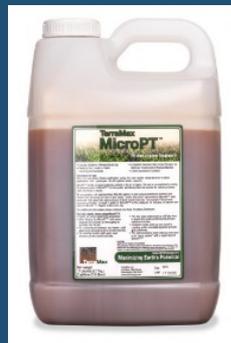


Photo Ni

Manure additives: past & present

- Started in Europe to reduce ammonia loss from poultry manure in the 19th century.
- First additives were chemical preservatives, such as acid phosphate, to reduce ammonia loss from poultry manure.
- Introduced to the U.S. in the 1890s.
- Many products now used in Europe and Asia.
- Currently > 50 commercial manure additive products in North America.



Products in Belgium



Product in China

Photos Ni

A list of products in US & Canada

54 commercial additive products in the market in 2018

Table 1. List of the current manure additives in North America

Additive name ¹⁾	Manufacturer or distributor	Main ingredient	Brief summary of claimed product effectiveness	3 rd party test ²⁾
AgraSphere / AgraSlat	Bioverse Inc, Pipestone, MN	Blend of bacteria and microbes	Lagoon activation, treatment, and maintenance.	
Agriculture Manure Treatment Blend	Acti-Zyme, Grand Forks, BC, CAN	Granular organic microbe	Reduce sludge buildup; break down and liquefy proteins, starches, carbohydrates, and fats.	L & F, 0 (Vandenberg and Elvestad, 2014)
Agri-Clean [®]	Aspen Veterinary Resources, Ltd. Liberty, MO	Wetting, dispersing and emulsifying agents	Removal of organic matter in poultry, swine and other livestock premises.	L, 0 (Tengman et al., 2001) ³⁾
Alken Clear-Flo [®]	Alken-Murray Co., New Hyde Park, NY	Blend of bacteria	Control odors.	L, + for odors and hydrogen sulfide (Tengman et al., 2001); L, 0 for odors (Wheeler et al., 2011)
Alken Enz-Odor [®] 5	Alken-Murray Co., New Hyde Park, NY	Dry blend of bacteria	Liquefy, metabolize, deodorize. Not produced for manure, but tested for manure application.	L, 0 for odors (Wheeler et al., 2011)
ASI Pit Slammers [™]	Hog Slat, Inc., Newton Grove, NC	Bacterial spores	Reduce pit crusting and odor. In solid blocks that can be slipped through slatted floors.	
ASI Anti Foam	Hog Slat, Inc., Newton Grove, NC	N/A	Prevent and break down foam. Use with ASI Pit Hammer.	
ASI BioBlock	Hog Slat, Inc., Newton Grove, NC	Enzyme producing bacteria	Break down solids; reduce odors.	
ASI Maintenance	Hog Slat, Inc., Newton Grove, NC	Bacteria	Reduce organic solids; control odor; provide insect management.	
ASI Pit Hammer	Hog Slat, Inc., Newton Grove, NC	Bacteria	Digest and liquefy solids to reduce odor; control insect infestations.	
ASI Pit Hammer Plus	Hog Slat, Inc., Newton Grove, NC	Bacteria	Digest and liquefy solids to reduce odor; control insect infestations.	

How do additives work

Working principles:

- Chemical: acids, oxidizing agents, disinfectants
- Microbiological: bacteria microbes
- Biochemical: enzymes, urease inhibitors
- Physical: absorbents, barriers
- Physiological: masking agents

Most of the commercial additives are proprietary.



Photo Ni

Chemical additives

Tested for ammonia emission reduction:

- Super-phosphate ($\text{Ca}(\text{H}_2\text{PO}_4)_2$)
- Paraformaldehyde $\text{OH}(\text{CH}_2\text{O})_n\text{H}$ ($n = 8-100$)
- Phosphoric acid (H_3PO_4)
- Sulfuric acid (H_2SO_4)
- Aluminum sulfate ($\text{Al}_2(\text{SO}_4)_3$)
- Aluminum chloride (AlCl_3)

Others reportedly reduce odors:

- Calcium peroxide (CaO_2)
- Hydrogen peroxide (H_2O_2)
- Potassium permanganate (KMnO_4)
- Disinfectants

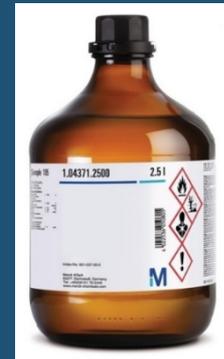


Photo from internet

Microbiological & biochemical products

- Bacteria, enzyme, or antibiotic products.
- Microbial- resistant materials, such as humic additives
- Mechanisms complicated and much are unknown.
- Some commonly reported include:
 - Urease inhibitors
 - Antibiotics
 - Blends of bacteria



Photo by William D. Flemming

Photo shows Roper unloading whey to control odor in his lagoon. He treats the lagoon once a week with whey he gets from area cheese plants.

**He Uses Cheese Whey To
Control Odor In Lagoons**

Image (Houtsma, 1997)

Plants, minerals, and soils

Reacting with manure physically, chemically, and/or biochemically.

- Zeolite
- Gypsum
- Lime
- Minced horseradish roots
- Yucca saponin (a class of chemical compounds found in various plant species)
- Nitrifier seeds (a material from the top centimeters of the dirt floor of a chicken house)
- Soybean peroxidase (an enzyme found in the root, leaf, and hull of the seed *Glycine max*)

Forms of additives

- Liquid form: relatively easy to prepare (e.g., dilute to desired concentrations) and apply.
- Solid form: easy to store and transport. Some are granular or powders that can be dissolved in water before application or directly applied onto manure surfaces.
- Self-dissolving solids in different shapes to slowly release the contents into the liquid manure over a period of time.
- Dissolvable additives in small containers of different shapes, e.g., balls or bricks.



Photos from internet & Ni

Effectiveness: how do we know

- Manufacturers' product descriptions and anecdotal testimonials;
- Extension publications and presentations;
- Scientific research reports;
- Word-of-mouth.



Photos from internet

Effectiveness: what are known

- Mixed results on effectiveness and consistency for most products.
 - Exception: acidifiers on ammonia emission.
- Duration of effectiveness can also vary, lasting from 24 hours or less to over a period of months.



Photo Ni

Effectiveness: examples

- A 35-product lab test, reduction @ 75% confidence (Tengman et al., 2001):
 - 4 for odor
 - 10 for H₂S
 - 12 for NH₃
- Our review of 54 products, 16 tested (~30%) by 3rd parties in 21 studies:
 - 11 products with positive results
 - 10 products no effects
 - (2 products with inconsistent results)

<http://www.extension.purdue.edu/extmedia/ABE/ABE-161-w.pdf>
(*Google search*: purdue extension manure additive)

How are additives tested

- Controlled laboratory test
- Field test
- Both lab and field tests:
 - Treated vs control
 - Comparison of additives



Iowa



Indiana



Pennsylvania

Photos from internet, Ni, and Wheeler et al. (2015)

A 35-additive study



Additives samples



39 reactors



Mixing



Instruments

(Tengman et al., 2001)

Limitations of lab and field tests

- Lab tests
 - Scale effect: millions of gallons vs a few gallons
 - Short-term vs long-term
- Field tests
 - Identical barns/lagoons;
 - Control of ventilation; animals
 - Degradation of samples
- More studies are needed
 - Only ~30% of additives have been independently tested and results published.



Photo from internet

Handling and safety with additives

Follow the Material Safety Data Sheet or other product guidelines

- Store in cool, safe, well-ventilated places, and avoid direct sunlight.
- Keep away from children and animals.
- Wear protective clothes and respiration masks as needed.
- Avoid excessive inhalation of the vapor from the additives.
- Wash hands with warm, soapy water after handling.

An example of pig poisoning

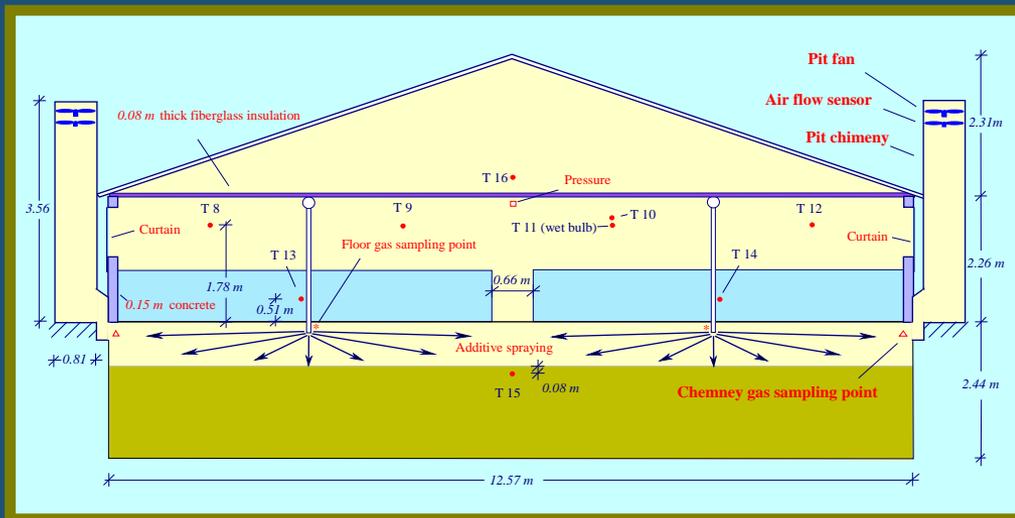
- An incident in the Netherlands: 582 pigs died of hydrogen sulfide (H_2S) after 1500 gallons of manure additive (lactic acid) was dumped in the slurry pit (Borst, 2001).



Photo from internet

Application of additives

- Most require simple methods, such as pouring or spreading the products directly into the manure pits.
- A few requires sprayed evenly over the manure surface at certain time intervals.



Drawing Ni; Photo from internet

Application dosage and frequency

- Recommended dosages by product manufacturers should be followed. The most common units are based on the following:
 - Per manure volume, in gallons or cubic feet;
 - Per manure pit surface area, in square feet;
 - Per manure flow rate into lagoons, in gallons per minute;
 - Per animal, in head per year (e.g., per cow per year);
 - Per animal unit (1,000 lbs.), in animal unit per year.



Photos from internet

Costs of additives

- Costs differ significantly, usually include the following:
 - Application equipment (Most do not require special equipment)
 - Labor and service
 - Additive product, shipping and handling, calculated with different application dosages. For example:
 - MicroPT™ is listed \$191.45 / 2.5-gallon container.
 - Application rate is 1 gallon per 100,000 gallons of waste (10 ppm).
 - A one-million-gallon manure storage needs \$1,914 of MicroPT™ additive.

Costs effectiveness

- Depend on products and calculation methods
 - For example, research demonstrated cost effective for alum to reduce ammonia release from poultry litter (Lorimor et al., 2002).
- Objectively obtaining the benefits is usually difficult because some benefits are intangible or impossible to quantify and monetize.
 - For example, reduction in odor or gas emissions and improvement in public relations.



Photo from internet

Summary

- Manure additives have a long history and are usually easy to use;
- There are > 50 products in U.S. & Canada;
- Different mechanisms are involved in different products, some are unknown;
- Results of effectiveness are mixed;
- Lab and field tests have limitations;
- Cost effectiveness depends on calculation methods.

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