pH MATTERS
by JONES-HAMILTON CO.

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WE KNOW pH MATTERS

UNDERSTANDING ACIDS AND THEIR POTENTIAL IN POULTRY LITTER

Treating litter with an acidifier is a fairly common practice in poultry production, used as a way to control ammonia and maintain a favorable environment for bird welfare. While the benefits of acidification are often discussed, most people don't often think about what qualifies a chemical as an acid, the different types of acids, and how they work.

WHAT EXACTLY IS AN ACID?

An acid is any chemical capable of producing a hydrogen ion in a solution, namely water. This is an important point, because water is necessary for an acid to be generated. When added to water, an acid increases the number of hydrogen ions, thereby lowering the pH.

pH is a measure of hydrogen ion concentration in water

TYPES OF ACIDS

There are two types of acids – organic and inorganic. Organic acids are carbon-based and have higher pKa values, which indicates the ability of an acid to lower pH. Inorganic acids are mineral-based and have a lower pKa value, meaning less is needed to reach a low pH environment. Organic acids will require a much higher addition rate to achieve a low pH, which can be costly or simply ineffective.

MEASURING THE STRENGTH OF AN ACID

		pKa Value
Greatest Ability to Lower pH	Hydrochloric Acid	-6.1
	Sulfuric Acid	-3.0
	Sodium Bisulfate	1.99
	Phosphoric Acid	2.12
	Lactic Acid	3.08
	Citric Acid	3.14
	Formic Acid	3.75
Least Ability To lower pH	Acetic Acid	4.75
	Propionic Acid	4.87

Table 1. Acids grouped by pKa value (1998 Edition of CRC)

To measure the strength of an acid you measure its pH, or hydrogen ion concentration. The lower the pH, the more hydrogen ions present. Any solution with a pH above 7.0 is considered basic; below 7.0 is acidic.

Hydrochloric and sulfuric acids are strong inorganic acids, as indicated by their negative pKa values, that are very corrosive and dangerous to handle. Sodium bisulfate and phosphoric acid have similar pKa values, meaning their impact on pH will also be similar. Acids with higher pKa values, such as acetic and propionic acids, are weak acids and would require significantly higher addition rates to effectively lower pH (Table 1).

ACIDS AND POULTRY LITTER: WHY pH MATTERS

Level of Bacterial Growth at Varying pH Levels				
pH	E. coli	Clostridium	Salmonella	Pasteurella
7.4	Heavy	Heavy	Heavy	Heavy
7.0	Heavy	Heavy	Heavy	Heavy
6.8	Heavy	Heavy	Heavy	Moderate
6.5	Heavy	Heavy	Heavy	Light
6.4	Heavy	Heavy	Heavy	Light +
6.3	Heavy	Heavy	Heavy	Very light
6.2	Moderate	Heavy	Heavy	Very light
6.0	Moderate	Heavy	Moderate	Very light
5.8	Light	Heavy	Light	Very light
5.7	Light	Heavy	Very light	**ZERO**
5.4	Very light	Moderate	Very light	**ZERO**
5.2	Very light	Moderate	Very light	**ZERO**
5.0	**ZERO**	Light	Very light	**ZERO**
4.8	**ZERO**	Light	**ZERO**	**ZERO**
4.5	**ZERO**	Very light	**ZERO**	**ZERO**
4.3	**ZERO**	**ZERO**	**ZERO**	**ZERO**

Table 2. Effects of pH on Bacteria (Roney et al, 1989)

When the pH of poultry litter is lowered below 7.0, the ammonia present in the litter is converted to ammonium. Ammonium can form a salt, which as a solid, stays in the litter rather than volatilizing in the air. In gas form, ammonia poses significant health and performance risks to birds, at levels as low as 25 PPM.

While ammonia control is a significant benefit of pH reduction, additional benefits can be gained by lowering the pH even further. A diverse ecology of beneficial and harmful bacteria exists in poultry litter. Beneficial bacteria, such as *Lactobacillus*, thrive in the low pH environment created with the addition of acids. Conversely, harmful bacteria, such as *Salmonella*, cannot survive in low pH environments below 5.0.

WHEN AN ACID ISN'T AN ACID

As previously discussed, all acids require a solution to be effective, meaning the hydrogen ion must dissolve in water. Since excess moisture in poultry litter has the potential to support the growth of harmful bacteria and increase ammonia concentrations, it stands to reason that the use of acids requiring the addition of water for activation could introduce challenges.

Some products sold as acids aren't technically acids. Lewis acids, such as alum, are not typical acids. They do not contain hydrogen ions to directly lower pH, which begs the question - how can they lower pH? Alum has to accept electrons from water, causing hydrolysis to produce a hydrogen ion. But it can only do this when it comes in contact with water in physically wet litter - not ideal litter conditions for birds. These products also contain aluminum, which when put in a solution causes hydrolysis, which ends up generating a small amount of hydrogen ions. It is notable that a lot of water must be present for this to happen.

For this reason, hydroscopic acids such as sodium bisulfate, which can pull water or moisture from the air to activate, offer the added benefits of pH reduction without the introduction of additional water.

WHAT DOES THIS MEAN WHEN SELECTING A LITTER ACIDIFIER?

Product	Characteristics
SULFURIC ACID	Corrosive with hazardous ratings that are a safety concern, has the ability to char, can burn skin on contact, as in Poultry Guard (acidified clay) and Acidified Aluminum Sulfate (A-7). Do not let birds come in contact with liquid sulfuric acid.
SODIUM BISULFATE	Non-hazardous, dry granular acid on EPA Safer Choice list that easily dissolves in water, dissociating into sodium ions, hydrogen ions and sulfate ions. Hydroscopic (no additional water necessary); ability to lower pH below 4 with minimal addition rate.
PHOSPHORIC ACID	Sold in liquid form, presents challenges for litter disposal since it adds more phosphorous to the land when applied as fertilizer, the addition of phosphorous to the water stream is regulated
CITRIC ACID	Not hydroscopic (requires significant addition of water to activate)
FORMIC/ACETIC/ PROPIONIC ACID	Not commonly used as acidifiers due to their high pKa value
ALUMINUM SULFATE (ALUM)	Under wet litter conditions, aluminum sulfate will hydrolyze slightly lowering litter pH. Aluminum can and will accumulate in the litter over many uses.

30354 Tracy Road, Walbridge, Ohio 43465-9792 • Ph: 419.666.9838 • 888.858.4425
Fax: 419.666.1817 • www.JonesHamiltonAg.com

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