Disinfectant Actives Review, Part 3 of 5

Comparing and Contrasting Formaldehyde vs. Glutaraldehyde

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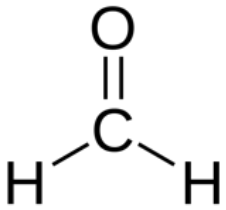

Fig. 1. Formaldehyde

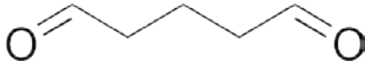

Fig. 2. Glutaraldehyde

One thing is certain when using disinfectants in live production: whether you are in a sow nursery or finisher site, the high organic load challenge associated with a somewhat "cleaned" or "dry-cleaned" surface means that we really ask a lot from our disinfectants. Disinfectants, by design and testing, are chemicals that are used to kill something. In animal health, that *something* is preferably a population of bacteria, viruses, protozoa, and fungi. So if we are going to be using a chemical to kill something, that chemical must somehow be toxic to the *micro*-organism bug at a given exposure concentration and time—without being toxic to the *macro*-organisms (i.e., a hog or human) being exposed—*or* the chemical exposure to the animals or employees must be controlled, minimized or eliminated.

Aldehydes represent one chemical class of disinfectants that have a long and proven history of successful use in controlling pathogens in animal production. Formaldehyde **[Fig. 1]** is the simplest, lowest molecular weight aldehyde and has been used worldwide since its discovery in the 1800s. Formaldehyde has numerous uses as a chemical reactant for manufacturing of diverse products outside of animal health, including various polymers, resins, insulation, adhesives and textiles. In swine facilities, it is used primarily as a fungicide and bactericide (including spores).

Formaldehyde's longtime, proven success as a gas phase disinfectant seems to have come with a price: the same ability of the chemical to react with primary amines in proteins or DNA, thus killing a microbial pathogen, also creates an exposure safety issue for humans. In 2004, the International Agency for Research on Cancer (IARC) reclassified formaldehyde as a known human carcinogen based on animal data, laboratory *in vitro* studies, and epidemiological evidence[1,2]. The U.S EPA had classified formaldehyde in a somewhat more illusive light—as a Class B1 carcinogen (probable human carcinogen) since 1987—linking the molecule specifically to respiratory tract squamous cell carcinoma[3]. However, in June of 2010, EPA re-classified "…formaldehyde as carcinogenic to humans"[4]. For this reason, use of formaldehyde is always coupled with personal protective equipment (PPE) especially for respiratory exposure. While most companies who choose to continue using formaldehyde do an excellent job at monitoring health status of their employees and limiting employee exposure to formaldehyde with OSHA-approved PPE and post-treatment re-entry procedures, others have looked to the arsenal of safer disinfectant alternatives. Within the aldehyde chemical class of disinfectants, that choice has often been glutaraldehyde **[Fig. 2]**.

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There are many misconceptions as it relates to understanding the differences between formaldehyde and glutaraldehyde. Glutaraldehyde is an aldehyde, but the similarity in chemistry does not necessarily equate to the toxicological profile and biological risk for humans. An analogy can be made to the chemical class of alcohols. Ethanol and methanol are both alcohols. Ethanol is an excellent, low-toxic disinfectant for solid surfaces (found in liquor, wine and beer) and, while safe to drink, does have "short term effects" after consumption; methanol consumption, however, can cause severe ocular toxicity (i.e., blindness).

Glutaraldehyde, unlike formaldehyde, is not regulated by the federal government as it relates to release and, thus, its use can eliminate some of the administrative burden associated with formaldehyde. Glutaraldehyde has *not* been classified as a human carcinogen by the European Union or the U.S. EPA, and has *not* been evaluated by IARC for carcinogenicity. Glutaraldehyde does *not* "release" formaldehyde and does *not* spontaneously break down into formaldehyde in animal production situations.

Glutaraldehyde is a liquid and delivered as a disinfectant in aqueous solution, whereas formaldehyde is a gas phase disinfectant. As with most disinfectants, glutaraldehyde use must always be accompanied by the use of proper PPE to limit skin and respiratory exposure. Some gluteraldehyde formulations can be used with fogging equipment, again with proper PPE, and carefully following the instructions on the label.

Some disinfectants used in live animal production as a "dry cleaning" and in traditional C&D wet cleaning operations can end up as a persistent in the environment (i.e., soil, water). These disinfectants, by their nature, can be an obstacle to biodegradation by microbes, or can bioaccululate in biota. In one study by McIlwaine[5] in 2002, glutaraldehyde passed and exceeded biodegradation requirements set by OCED protocols 301A and 306. Glutaraldehyde is an organic molecule and biodegrades into either glutaric acid and then carbon dioxide (aerobically), or into 5-hydroxy pentanal and then 1,5-pentanediol (anaerobically). These final products are not biocidal and do not accumulate in the environment. In the environment, aldehydes react quickly and irreversibly with primary amines, likely being consumed by either microbes or amines/ammonia.

When surveying options for a disinfectant, it is difficult to overlook the utility of aldehydes as an excellent tool for live production. Aldehydes generally perform well in moderate organic loads, can be effective against a wide range of pathogens (including mold spores) and, thus, can also be very cost-effective. Glutaraldehydes are sold into swine in gallons, 5 gallons, and drums, and include a straight 20% glutaraldehyde (i.e., Glutex GS-2; Dow Chemical), along with glutaraldehyde/quat blends like Synergize (Neogen Corp.) and Glutex GQ-1 (Dow Chemical).

As with any disinfectant, the cleaning phase generally sets the stage for ultimate success or failure—depending on your expectations. Any disinfectant works best once most of the soil and microbes are, first, physically removed from the surface; without cleaning, you will likely never reach the potential of a disinfectant to destroy five logs of microbes in 10 minutes (disinfecting) or three logs of microbes in five minutes (sanitizing). *Reduction in pathogen populations can occur without cleaning first*, but likely at much lower levels than reported on any disinfectant label. Remember: Disinfectants are designed to kill bad bugs and not impact humans, so always wear appropriate PPE as described on the label and adhere to label instructions regarding exposure to swine and livestock.

References

[1]*IARC Monographs on the Evaluation of Carcinogenic Risks to Humans*, Vol. 88, "Formaldehyde, 2-Butoxyethanol and 1-*tert*-Butoxypropan-2-ol", 2006.
[2]Cogliano *et al*. "Advice on Formaldehyde and Glycol Ethers" *The Lancet Oncology*, Vol. 5, Issue 9, September 2004, p. 528.
[3]U.S. Environmental Protection Agency – Formaldehyde CASRN 50-00-0, 1989
[4]U.S. EPA. IRIS Toxicological Review of Formaldehyde (Interagency Science Consultation Draft) . U.S. Environmental Protection Agency, Washington, DC, EPA/635/R-10/002C, 2010.
[5]McIlwaine, D., "Challenging Traditional Biodegradation Tests: The Biodegradation of Glutaraldehyde", *Proceedings and Abstracts of the 9th Annual Meeting of the International Petroleum Environmental Conference*, Oct 22-25, 2009, Albuquerque, NM

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