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The 3 "E's" of Dry vs. Wet Foot Pans for Biosecurity: Economical, Effective, and Easy

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INTRODUCTION

The use of biosecurity foot pans at critical entrance points into and throughout a live poultry production facility is again front-and-center in lieu of the current 2022 avian influenza status within the U.S. Complicating this issue even further is a continued raw materials supply-chain shortage plaguing nearly all global business sectors, including the chemical disinfectant, pharmaceutical, and materials manufacturing industries. Coupled with labor recruitment, training, and retention challenges also facing the poultry and livestock and food production pieces of the protein sectors, more than ever 2022 is a year to reflect on internal processes and procedures and how well the standard best biosecurity management practices are holding up to (employee execution) compliance, profitability, and true protection against animal and food safety pathogens.

The foot pan is actually a very odd piece of our business in live poultry production... and not very many employees (if any) view the foot pan as a welcomed, utilitarian and standard "every day" part of protocol impacting movement onto and within farms, offices, hatcheries, feed mills, and processing plants. At best it slows things down just a little and adds (nearly negligible) cost to live production, and at worst it feels like a waste of time and money to use properly.

Using foot pans (and for most biosecurity protocols and materials, in general) often feels a lot like buying insurance; it simply operates in the background of your operation, without your thinking about it too often, and you hope it is ready, paid for and executed, and actually works in the rare case you might need it (to actually work properly)... but you really hope you never need it at all.

This disconnect between the actual proper set-up, use, and enforcement of biosecurity is basically due to two things happening simultaneously:

1) The desired outcome of biosecurity is that nothing at all happens, and

2) The culture of biosecurity (like establishing a culture of safety within a company) usually lacks "teeth", often taking a back seat to more pressing matters of day-to-day disease prevention and management, executing standard daily protocols with the labor available that day, and always keeping a keen eye on opportunities to either make things simpler or cheaper.

This last piece can be the catalyst for re-thinking the foot pan for your operation; simple, cost-effective, and working the best to manage diverse pathogen challenges facing veterinarians and live production managers throughout the layer, turkey, and broiler businesses in the U.S.

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The Limitations of (Seemingly) Any Liquid Foot *P*an Disinfectant

While biosecurity is a 24-7 year-round combination of materials and a process, certain weather and times of year make this process difficult...depending on the placement of the foot pan. Despite the best efforts of live production staff and farm owners to identify the most suitable location for foot pans, they are universally very poorly maintained and mostly ignored. When the foot pan is small enough, personnel will often step over or around the pan to avoid stepping into the pan. This is most often a problem for wet foot pans containing diluted disinfectant that can leak into footwear that may be damaged (holes), causing skin irritation or the discomfort of wet socks for an entire shift. Jumping over can also be dangerous for employees, potentially causing slip-and-fall scenarios.

Wet foot pans containing diluted disinfectant have previously been shown to have a very short lifespan as an effective tool to kill pathogens on footwear. In a study performed at a Hubbard hatchery by Dr. Bob Owens *et al.* (**2006**), the authors demonstrated two very distinct pieces of data, showing ***liquid foot pans*** are:

1) quickly inactivated after only a few uses (**Figure 1**), and that

2) this inactivation seemed mostly indifferent as to the chemistry applied to the foot pan (quat vs. phenol; **Figure 2**).

	Fresh Solution	After 3 Hours
Active	*% Change in Bacterial Count*	*% Change in Bacterial Count*
Phenol	-45.8	130.5
Quat	-57.5	73.3
Water	87.2	44.8

Figure 1. Total bacteria counts from shoe swabs

Phenol and quat liquids kill bacteria in fresh disinfectant, but after only 3 hours bacteria actually increased on shoe swabs, suggesting non-protection of the deactivated disinfectant liquid foot pans.

	Fresh Solution	After 3 Hours
Active	Before>After 25 exposures *Increase in Bacteria*	Before>After 25 exposures *Increase in Bacteria*
Phenol	36 -> TNTC	TNTC -> TNTC
Quat	1 -> 12	185 -> TNTC
Water	19 -> TNTC	TNTC -> TNTC

Figure 2. Total bacteria counts in the disinfectant dilution liquid

Phenol and quat liquids are inactivated, allowing for bacteria to survive and/or grow in the foot pan liquid after only 25 uses. After the solution sits for 3 hours, bacteria thrive in the organic material dilutions of quat and phenol.

The data is not only important because it shows that the organic material introduced into foot pans inactivates the disinfectant solution, but also that the dirty, deactivated foot pan can quickly become an actual reservoir to spread microbes after stepping into the liquid solution. As a follow-up to this date, the authors decided to test dry foot pan materials and their ability to reduce microbial counts on boots.

At the hatchery prior to the chick room (break room entrance), employees' boots were swabbed prior to and then after stepping into either liquid phenol or quat disinfectant, or dry chlorine bleach powder (alone or with detergent) for 5 to 10 seconds. The results of the "real world" trial are summarized in **Figure 3**. One important note is the poorest performance of phenol, the chemistry often touted as being "more resistant to high organic load", tolerant of dirty surfaces when compared to other conventional disinfectants like quats, oxidizers, and alcohols (**CFSPH 2021**).

Active	*% Change in Bacterial Count*	*% Change in Bacterial Count*
Dry Bleach + Soap	-92.6	14 days
Dry Bleach Powder	-98.1	14 days
Phenol (liquid)	10.8	<2 hours
Quat (liquid)	-23.6	<2 hours

Figure 3. Reduction in bacterial counts on hatchery employees' boots after 5-10 second contact time with liquid and dry antimicrobials

Average residual lifespan estimated (calculated) based on available chemistry (molarity) and deactivation by organic load from all data (**Owen and Lawlor, 2006**).

Liquid disinfectant foot pans have another few disadvantages besides being irritating on wet socks (leaky boots), slippery on spongy foot bath mats, and rapid deactivation compared to dry products; wet foot pans in poultry live operations quicky transfer organic material into solution, creating a visible messy and murky soup that no professional would ever encourage their employees to step into. This further impacts the "culture of biosecurity" problem:

"How do poultry health professionals encourage, support, and enforce biosecurity protocols that they themselves can not technically verify and demonstrate as visibly "making sense" (*i.e.*, not a murky filthy foot pan) to contract growers and flock management staff?

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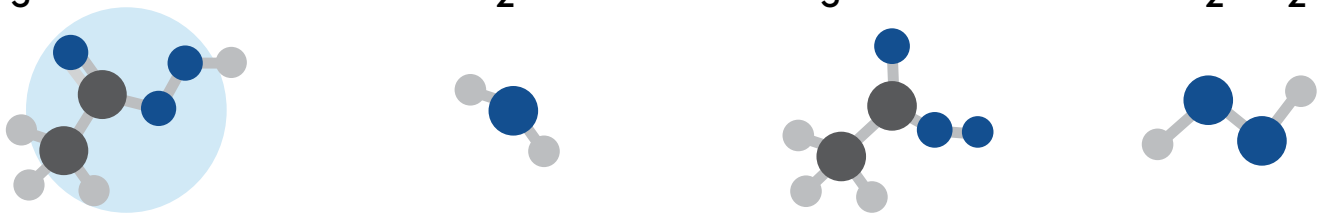
Dry Bleach Can Be Challenging

While dry bleach proved itself to outperform liquid disinfectant solutions in foot pans, this powdered chlorine has a few drawbacks that have created a challenge to becoming a clear replacement for biosecurity liquids. ***Off-gassing*** of chlorine is a notorious characteristic of di- and trichlor-based solid bleach powders. The chlorine released from the powder into the immediate space surrounding the dry bleach foot pan is not only potentially ***annoying*** to employees and animals (due to the smell), but also can ***oxidize/rust metals*** in that area, including switches, controllers, and fixtures. When placed into foot pans in very wet areas, some dry bleach products can become ***"slick"***, causing a potential hazard for areas around high water usage on smooth floors, or complicated by melted snow and heavy rain at doorways.

A Quat-Free and Bleach-Free Alternative; A 2022 Granular Spin on Old Liquid Chemistry

Organic acids have been well described as having diverse antimicrobial activity against diverse bacteria and fungi (**Martin and Maris, 2005**), with acetic acid and lactic acid having one of the greatest efficacies in organic loads (**Cherrington *et al.*, 1992**). Their even more powerful synergy with the simple combination with hydrogen peroxide in a simple mixture was described by the same authors seven years later (**Martin and Maris, 2012**). When the chemistries of hydrogen peroxide and select organic acids combine under certain conditions, they form a new and very effective peroxyacid compound... having very interesting microbial killing capability characteristics. The one peroxyacid that has led the change into pathogen intervention is peracetic acid (or "PAA"; **as seen in the equation below**).

$$CH_3COO\text{-}OH + H_2O \leftrightarrows CH_3COOH + H_2O_2$$



PERACETIC ACID (PAA) + WATER ⇆ ACETIC ACID + HYDROGEN PEROXIDE

Peracetic acid is normally (conventionally) formed in a liquid environment, the two reactants being added to a vessel and with a little help from an acid catalyst forms PAA. The formation of this molecule in liquid was industrialized for manufacturing prior to WWII, but has only been in commercial use for the last 50 years. In 2021, the EPA granted approval for pathogen claims for the world's first solid peracetic acid granule invented and commercialized by Enviro Tech (**Harvey and Howarth, 2018**). This specialized hygroscopic formulation uses a somewhat similar (but unique) approach to create biocidal PAA from the moisture-activated powder without the need for vinegar (also known as acetic acid).

The PeraGuard AH granule offered to customers for the first time in 2022 breaks down into innocuous by-products, like soda ash, glycerin, water, CO_2, and oxygen. The lack of vinegar means that there is not strong smell (like liquid PAA) or off-gassing like bleach powder, and the formula is not slippery or dusty. Further, there is not known bacterial resistance to PAA and with the solid granule in a foot pan, you only need to add more material to the pan as it contacts footwear and is carried out of the pan. The continuous release of PAA over time gives a strong initial kill and long-lasting protection.

When compared to other EPA-approved foot pan powders, PeraGuard AH has economic advantages and is easy to use ("add to, no need to throw out and replace"). The simplicity of not having to empty and then clean dirty liquid foot pans... or throw away old, expired powder after a few weeks... means better compliance, and a stronger culture of easy, enforceable biosecurity within poultry health leadership, contract growers, and integrator staff. If you can simply see the granules still there in the foot pan (and admittedly the pan is also not full of dried manure), then the moisture-activated PeraGuard AH is still available to help control pathogens on boots into and within your poultry facility.

Biosecurity in a foot pan has never been so Economical, Effective, and Easy to accomplish!

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