Disinfection in On-Farm Biosecurity Procedures

William P. Shulaw, D.V.M.
Extension Veterinarian, Cattle and Sheep

Gary L. Bowman, D.V.M.
Extension Veterinarian, Swine
The Ohio State University

Since the appearance of foot-and-mouth disease (FMD) in Europe in early 2001, its possible introduction into the United States has caused many livestock owners serious concern, so much so that many are now looking more closely at their biosecurity plans or their efforts to keep the disease out of their herds. Extension veterinarians have received many calls regarding which disinfectants to use on shoes, boots, tires, or other equipment in order to kill the foot-and-mouth disease virus. A few important points about disinfection should be made before choosing a disinfectant for routine farm use.

First, most disinfectants won’t work if the surface to be disinfected isn’t clean before applying the disinfectant.

Steam and high-pressure washers can be very useful to clean porous surfaces. Organic materials such as soil, plant debris (like straw), milk, blood, pus, and manure often inactivate some disinfectants or protect germs from the disinfectant’s active ingredients. Chlorine-based disinfectants are especially subject to this problem. Chlorine, the active ingredient in bleach, is relatively quickly inactivated by organic debris such as manure, and even milk, at the concentrations usually used on clean surfaces.

In addition, even “hard” water can reduce or destroy the activity of some disinfectants. Likewise, some disinfectant solutions are only active for a few days after mixing or preparing. Failure to make a fresh solution of disinfectant after it has been prepared longer than a few days, or after it has become visibly contaminated by organic material like manure, may result in using a product that doesn’t really work. Even worse, it may give a false sense of security. It is true that sufficient concentration and contact time can overcome some of these problems with certain classes of disinfectants, but often increasing the concentration or contact time makes use of the product impractical, costly, or caustic.

Disinfectants also vary considerably in their activity against the assorted germs — bacteria, viruses, fungi, and protozoa — about which livestock producers are concerned.

For example, plain vinegar (4% acetic acid) will readily kill the foot-and-mouth disease virus, but it won’t do much to Mycobacterium paratuberculosis, the cause of Johne’s disease. Most commonly used disinfectants are not active against bacterial spores, the environmentally hardy life form taken by the germs that cause tetanus, blackleg, botulism, and anthrax. Yes, formaldehyde is effective against most spores, but it is not really a practical disinfectant and is now considered a potential cancer-causing compound.

It is important to select a disinfectant that will be active across a wide spectrum of germs under the conditions in which it will usually be used.

These conditions include hard water, contamination with organic material, and potential for toxicity or damage to environmental surfaces or skin and clothing. It is also important to keep solutions clean and freshly made as directed by the manufacturer.

Lastly, disinfectants must have sufficient contact time with the surfaces to which they are applied in order to allow them to kill the germs with which we are concerned.

Contact time needed varies with the product and the germ. A quick splash of a dirty boot in a foot bath is not likely to accomplish anything except to give a false sense of security. The chart of disinfectants on the next page has recently been made available by the USDA for field use in a foot-and-mouth disease outbreak ** and is useful in examining some of the previously stated points.
As you can see from the above, common household bleach would be an effective disinfectant for the FMD virus, but the recommended concentration (3% sodium hypochlorite) is 60% of full strength as it comes from the bottle. This concentration would damage clothing, shoes, and rubber goods and is mildly corrosive to steel surfaces. It can be used on an infected premise for FMD, but probably wouldn’t be a good choice as a general purpose disinfectant for equipment and foot baths. Vinegar will also kill the virus, but wouldn’t be a good choice for general use because of its lack of effectiveness against many other important germs. Obviously, lye is too caustic for general use.

On most farms, disinfectants will be used in foot baths or for cleaning equipment and livestock premises. The most commonly used disinfectants fall into the following classes.

**Quaternary ammonium.** The older quaternary ammonium compounds (Roccal D³) are good for some situations and relatively clean surfaces. They will not be particularly effective against FMD or *M. paratuberculosis*, the cause of Johne’s disease, and have markedly reduced activity in the presence of organic material. Some of the newer quaternary ammonium preparations have improved activity. Compounds in this class usually have some detergent action; however, they are usually inactivated in contact with many soaps or soap residues.

**Phenol-based compounds.** These compounds are coal-tar derivatives and often have a strong pine-tar odor. They usually turn milky when added to water and have good activity in hard water and in the presence of some organic material. They are considered active against many bacteria, viruses, and fungi, including the bacteria that cause tuberculosis and Johne’s disease. They are not especially active against the FMD virus; however, they are good all-purpose disinfectants for farm use. Some examples of this class of disinfectants include One Stroke Environ®, Osyl®, and Amphyl®.

<table>
<thead>
<tr>
<th>Product</th>
<th>Dilution</th>
<th>Mixing Instructions</th>
<th>Notes</th>
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<tbody>
<tr>
<td>5.25% Sodium Hypochlorite (NaOCl) (household bleach)</td>
<td>3%</td>
<td>Add 3 gallons of chlorine bleach to 2 gallons of water; mix thoroughly.</td>
<td></td>
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<tr>
<td>Acetic acid*</td>
<td>4–5%</td>
<td>Add 6.5 ounces of glacial acetic acid to 1 gallon of water; mix thoroughly.</td>
<td>Vinegar is a 4% solution of acetic acid.</td>
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<tr>
<td>Potassium Peroxymonosulfate and Sodium Chloride (i.e., Virkon-S)</td>
<td>1%</td>
<td>Follow label directions.</td>
<td>Virkon-S</td>
</tr>
<tr>
<td>Sodium Carbonate (soda ash)*</td>
<td>4%</td>
<td>Add 5.33 ounces of sodium carbonate to 1 gallon of hot water (or 1 pound to 3 gallons of hot water); mix thoroughly.</td>
<td>The solution is mildly caustic but can dull paint and varnished surfaces.</td>
</tr>
<tr>
<td>Sodium Hydroxide (NaOH) (lye)*</td>
<td>2%</td>
<td>Add 1/3 cup of NaOH pellets (2.7 ounces of the lye) to 1 gallon of cold water; mix thoroughly.</td>
<td>This solution is highly caustic. Use protective rubber clothing, gloves and safety glasses. <strong>WARNING:</strong> Always add the lye to the water. Never pour the water over the lye.</td>
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</tbody>
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* Section 18 application submitted and EPA approval is pending.
Hypochlorites. Chlorine compounds are good disinfectants on clean surfaces and have a broad spectrum of activity. They generally are more active in warm water. They can be somewhat irritating and can be harmful to clothing, rubber goods, and some metals. Some of the newer chlorine-based disinfectants are complex molecules that are less irritating and more effective than older ones such as bleach and Halazine®. Chlorine-based disinfectants are generally compatible with soaps but should never be mixed with acids. Their activity is strongly reduced by the presence of organic matter. Many chlorine solutions are unstable and need to be frequently replaced; read the label.

Iodophors. Iodine compounds have been used as antiseptics and disinfectants for many years. The iodophors are combinations of iodine and another molecule that makes them water-soluble. They are good disinfectants but are also not as effective in the presence of organic debris. Iodophors are generally less toxic than other disinfectants but can stain clothes and some surfaces. They are inactivated in the presence of some metals and by sunlight. They should not be mixed with quaternary ammonium disinfectants as they will be inactivated. Some examples of this class are Betadine® and Weladol®.

Newer compounds. New disinfectants are being introduced regularly. Some of these are oxidizing agents. Virkon® is a peroxyxide molecule/organic acid/surfactant combination (surfactants reduce surface tension to help water-based compounds penetrate). It appears to have a wide spectrum of activity against many kinds of germs (including the FMD virus). It is relatively stable in the presence of some organic material. It has a pH of around 2.6, when mixed as directed, but is labeled as nonirritating to skin. It is advertised as useful on many kinds of equipment, including saddles, brushes, buckets, etc. Another compound, based on peroxyacetic acid, is Oxy-Sept 333®. It is now EPA-approved for foot-and-mouth disease virus and is reportedly active against a broad spectrum of germs.

Remember, disinfectants are not to be applied to animals directly, unless labeled for such use, and you should consult the label to make sure there are no warnings against using them around feeders and in animal quarters. A general recommendation is to rinse disinfectants off after the appropriate amount of contact time if animals will have contact with the disinfected surfaces. Label directions should be strictly followed, and different classes of disinfectants should not be mixed.

In the event of a foreign animal disease outbreak, such as FMD, the type of disinfectant and procedures used in the cleanup of infected farms and for routine prevention activities will be selected by regulatory officials. For routine use in biosecurity programs at the farm level, producers should consider the major risks they are concerned about, consider the type of surface they wish to disinfect, the conditions under which the disinfectant will be used, and then select a disinfectant that best suits their needs. Information about activity in hard water or in the presence of organic debris, contact time needed, what germs are reliably killed, human use and environmental concerns, and other details are usually on the label or can be obtained from the company. Web sites are often good sources of information about individual products. Above all, producers should remember that disinfection is just one aspect of their biosecurity program.