Disinfection of stockyards

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Summary: Stockyards are premises where livestock from different sources are brought together for a period of time, before returning to their place of origin, or moving on to new premises or to the abattoir. Such premises pose particular problems for disease control, as they are potential sources for the dissemination of disease agents over wide geographical areas. The author describes a thorough programme of cleaning and disinfection for use during the routine operation of a stockyard. A different programme is described for use in the event of an outbreak of an Office International des Epizooties List A disease, taking into account the extra risks involved in such a disease outbreak.

KEYWORDS: Animal housing - Cleaning - Disease - Disinfection - Fumigation - Hygiene programme - Infectious agents - Livestock - Microorganisms - Pathogens - Pens - Stockyards.

INTRODUCTION

Stockyards are premises where livestock (cattle, goats, pigs and sheep) from different sources are brought together for a period of time, before returning to their place of origin, or moving on to new premises or to the abattoir. This definition includes exhibition pens, show pens, market premises, auction premises, performance testing stations and any temporary animal housing where livestock are brought together for the purposes of trade.

Movement of livestock within a country or across national borders increases the risk of disease outbreaks (e.g. the spread of porcine reproductive and respiratory syndrome [PRRS] through the movement of weaners and replacement breeding stock) (18). In the case of zoonoses, human health and life are also at risk.

The increase in world trade and advances in transport systems have resulted in a greater volume of livestock movement and, consequently, increased risks of disease.

Legislation and codes of practice (1, 2, 3, 4, 6, 8) (which often include instructions for cleaning and disinfection), veterinary health monitoring, vaccination programmes, quarantine measures and treatment all play a role in preventing the spread of disease. At the stockyard level, the use of an effective hygiene programme which includes cleaning and disinfection is an essential element of any disease control programme.

In practice, cleaning and disinfection are seen as less important than other aspects of animal husbandry. Little training or instruction is given to personnel, and there is a poor understanding of the mechanism of disinfection, and of the factors which affect the disinfection process.

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The aims of this paper are to provide an understanding of the practical aspects of disinfection, so that informed decisions can be made in the stockyard by those responsible for disinfection, and to provide a basic programme which can be adapted for use in different situations.

**STOCKYARDS AND THE SPREAD OF DISEASE**

Stockyards (as defined above) constitute a particular risk, for several reasons:

- Animals are transported to and from stockyards; transportation causes stress (particularly during loading and unloading) (11) and stressed animals are more susceptible to disease (12).

- Different species may come into contact with one another or use the same housing at different times, with the risk of infectious agents being transmitted from carrier animals or amplifying hosts to more vulnerable groups (e.g. pigs are amplifying hosts for foot and mouth disease [FMD] virus).

- Animals leaving stockyards may be dispersed over a wide geographical area.

- In the case of exhibition centres, markets and sale yards, the large number of visitors passing through the stockyard increases the possibility of disease dissemination.

It is therefore essential to ensure that animals entering a stockyard are healthy, that they remain healthy during their stay, and that they are free from disease on leaving the stockyard.

**DISSEMINATION OF MICROORGANISMS IN STOCKYARDS**

Animals shed, excrete, secrete and exhale microorganisms into their environment; infected animals excrete pathogenic (disease-causing) microorganisms. Pathogens localised in the upper respiratory tract are ejected, often in very large numbers, during breathing, coughing and sneezing. The larger droplets of moisture gravitate to surfaces in the immediate vicinity, while smaller droplets rapidly evaporate and remain airborne, carrying the pathogenic agents with them. Dust particles from the coats of the animals, and from bedding and feed become contaminated with skin, hair, saliva, pus and body excretions (16). Thus, housing, pens, feed, water and equipment in stockyards become contaminated by a wide range of microorganisms shed by livestock.

The numbers of microorganisms on surfaces in animal housing may exceed $10^9/cm^2$. Many of these microorganisms are non-pathogenic under normal circumstances, but may cause secondary infections when an animal is weakened by a primary infectious agent.

When infected animals are removed, the housing, pens, feed, water and equipment remain contaminated with microorganisms until measures are taken to remove these. The survival of infectious microorganisms in the environment plays a vital role in the transmission of disease. Many diseases can be transmitted through skin contact with contaminated surfaces (sheep and goat pox), or by the ingestion of contaminated feed and water (African swine fever). Some microorganisms can survive for long periods in the environment, particularly if protected by organic soiling such as manure. For example, orf virus in sheep does not survive outdoors but can survive for many years in...
buildings (20), and PRRS virus in pigs has been shown to survive in non-disinfected buildings for three weeks (17). New and susceptible animals introduced into contaminated buildings are challenged by these remaining microorganisms, and a cycle of infection can develop.

Without adequate cleaning and disinfection, re-infection and residual build-up of microorganisms perpetuate the infection cycle. To break the cycle, the building and associated equipment must be cleared of microorganisms. The only practical way to do this is by cleaning and disinfection, which should be performed each time the building is emptied and before new animals are introduced.

The aim of disinfection is to lower the microbial load on surfaces to a level which causes neither the spread of pathogens (less than $10^4$ colony-forming units/cm$^2$) nor a reduction in animal productivity.

**FACTORS AFFECTING THE PERFORMANCE OF A DISINFECTANT**

*In developing an effective and practical programme for disinfection, certain factors must be considered, which affect the activity of a disinfectant in use. These factors are described below.*

**Soiling**

The nature, degree and condition of soiling (organic and inorganic dirt) present affect the efficacy of a disinfectant (9). Hard, compacted soils are more difficult to disinfect than loose, friable soils; and solid soils are generally more difficult to disinfect than liquid soils.

Blood, urine, faeces, food debris, fats and dust are the most likely organic soils to be encountered in or on animal housing. Limescale (calcium carbonate) and milk stone (milk and hard water residues) are the most likely inorganic soils. In all cases, soiling reduces the activity of disinfectants. It is therefore important to clean prior to disinfection, except where the soiling presents a hazard, as in the case of an Office International des Epizooties (OIE) List A disease outbreak.

**Water hardness**

The degree and type of hardness of water used for dilution may affect the performance of a disinfectant (8). Hard water generally reduces the effectiveness of the diluted disinfectant. Many heavy-duty disinfectants, suitable for use in animal housing, have been tested for effectiveness when diluted using hard water (7, 10, 15). Hard water may cause precipitation of acids and alkalis, thus reducing disinfectant activity.

**Temperature**

Subject to the thermal stability of the disinfectant (9) (inherently reactive chemicals such as hypochlorite are unstable at high temperatures), disinfectant action is generally increased by raising the temperature at which the disinfectant is used (21). In practice, in countries with average water temperatures of approximately 10°C (e.g. France, United Kingdom, Austria), disinfectants are used which are known to be effective at cold temperatures. In Germany, it is recommended that hot water (40°C) or peroxygen disinfectants be used.
Contact time

The efficacy of a disinfectant increases with contact time (9). *Mycobacteria* spp. (which cause tuberculosis) take longer to kill than most other vegetative bacteria, while bacterial spores take longer still. Bacterial spores (e.g. the spores of *Bacillus anthracis*) are extremely resistant to environmental factors and disinfectants (not all disinfectants are effective sporicides). In practical situations, the disinfectant should be left in contact with housing and equipment for as long as possible.

Surfaces

Smooth, impervious surfaces are easier to clean and disinfect than rough, pitted surfaces (9, 12, 13, 19). In some circumstances, microorganisms may be protected from the action of disinfectants by attachment to porous surfaces. Bacteria can adhere to surfaces by forming biofilms which are difficult for disinfectants to penetrate.

Typical surfaces encountered in stockyards include the following: concrete (rough, finished or painted), wood (untreated, treated or painted), metal (stainless steel, galvanised, bronze, cast iron, aluminium or zinc, smooth or rusty), rubber, plastic, rigid foam and asbestos.

The effect of poor surfaces may be offset by good maintenance of equipment and buildings, plastering of walls, and the use of good-quality paint or varnish for wood.

DISINFECTION DURING REGULAR OPERATION OF STOCKYARDS

To maintain the efficient running of a stockyard, disinfection is required to prevent the transmission of infection to each new batch of livestock. Legislation exists in many countries to govern the movement of livestock (2, 8, 14). If the correct procedures are followed, livestock entering the stockyard should be free from infection. However, infection can develop while the animals are in the stockyard, or carrier animals may be present, showing no evident signs of disease.

The programme described below should be used to prepare pens or housing for each batch of animals.

**Step 1: Setting up**

The disinfectant and detergent to be used should be chosen, and care taken to read labels and prepare dilutions as required (the appropriate dilution of disinfectant depends on the level of risk and on the infectious agents likely to be present). Disinfectants should be mixed well: powders may require warm or hot water to dissolve completely, and thick liquid disinfectants should be diluted with water and mixed thoroughly. Acids and alkalis should always be added to water, not vice versa, as violent reactions can occur if small amounts of water are added to larger volumes of acid or alkalis. Disinfectants must not be mixed with other chemicals, or placed in containers which have been used for other chemicals.

The following equipment should be prepared: brushes, scrapers, pumps, power washers, backpacks, knapsack sprayers and personal protective equipment, if required (e.g. goggles, masks, gloves, overalls). Many types of power washers are available; these are powered by electricity, diesel oil or petrol, and operate at a range of pressures.
However, for use on farm buildings, pressures above 90 bar (1 bar = $10^5$ Pa) should not be employed. A maximum rate of delivery of 12 l/min is suitable. Different types of nozzles are also available, and the appropriate dispersal angle for nozzles used in cleaning is 25°-45°.

**Step 2: Removal of equipment**

If dust is a problem, water should be sprinkled over the area to ‘damp down’ dust before commencing the removal of equipment. Feeders, drinkers, pen separators and other movable equipment should be removed. These should be soaked or scrubbed in a tank containing detergent. After cleaning, they should be allowed to dry and stored away from possible re-contamination.

**Step 3: Removal of gross soiling**

Manure, soiled bedding and unused feed should be removed manually by using brushes, forks or a mechanical scraper. Industrial vacuum cleaners may be used to remove dust from ledges. Debris should be disposed of by burial, mixing with lime (1) or incineration; small amounts of organic waste may be left to decompose at a site located away from the premises which are being cleaned.

Where earth floors are present, the top layer of manure and debris should be removed down to the firm earth.

Exposed electrical points should be wiped clean and covered to prevent the ingress of water during subsequent cleaning. Alternatively, the electricity may be switched off and an alternative supply used to power the cleaning and disinfecting equipment.

**Step 4: Wet cleaning**

The whole building should be thoroughly treated with a detergent solution and left for 24 h if possible. Detergents break down organic soiling and reduce the amount of time required for subsequent cleaning.

Cleaning should be performed using a detergent solution to remove soiling from walls and floors. The detergent should be applied through a power washer (high-pressure/low-volume) if the fabric of the building or pen permits (high-pressure washers can be destructive, e.g. by removing mortar from walls). A low-pressure/high-volume system can be used, by simply connecting a hose to the mains water supply or storage tank.

Cleaning should begin at the apex of the building or at the top of the pen and work downwards to the floor and across to the drain, so that dirty water is not running across previously cleaned areas. Washing solution should be used at a dosage of 2-10 l/m$^2$.

**Step 5: Water system**

The water system should be drained (if possible) by isolating the header tank and draining off from points furthest from the tank. The tank should be cleaned, removing any sludge, and refilled with clean water. Disinfectant should be added and allowed to stand for a minimum of 10 min. This should then be flushed through to the drain-off points and left for 30 min. The tank should be refilled with fresh water and the system flushed through once more. If it is not possible to drain off the system, the tank should be isolated, allowed to run dry and then cleaned. Dirty water should be washed away by hosing down.
Step 6: Disinfection

The building should be allowed to dry after washing, if possible (this allows sensitive microorganisms to be killed by drying and removes the possibility of further diluting the disinfectant).

Disinfectant should be applied using a pressure washer at low pressure (35 bar), or using a knapsack sprayer or a pump attached to a sprayer. Spray should be directed into the apex of the roof, paying particular attention to corners, cracks and seams, continuing down the walls and across the floor to the drain. Disinfection of pens should commence at the top and proceed downwards, ensuring that both sides of pens are completely covered and that dirty water is flushed away from the base. Disinfectant solution should be used at a dosage of 0.3-1 l/m². The building should be allowed to dry before replacing cleaned equipment and fresh bedding.

Earth floors may be soaked with a strong disinfectant or caustic soda and should be left for as long as possible before re-stocking. Note that if phenolic disinfectants are used where pigs are to be housed, these chemicals must be allowed to dry before re-stocking as they are toxic for pigs.

In exhibition centres, where buildings and pens may be used sporadically, cleaning should be performed as soon as the animals have been removed. Disinfection may be performed at any time up to 48 h before the arrival of the next batch of animals. The period between cleaning and disinfection allows for drying, which aids the destruction of microorganisms. Where the building is used for other purposes (e.g. trade shows), for which animals are not present, disinfection needs to be performed after cleaning, and again before the arrival of the next batch of livestock.

Step 7: Cleaning and disinfecting equipment

The equipment employed in cleaning and disinfection (e.g. brushes and scrapers) should be cleaned by removing soilage and soaking or scrubbing with detergent and disinfectant. Equipment should be allowed to dry before re-use.

Power washers should be wiped or brushed down to remove gross soiling, and the exterior wiped with a cloth which has been soaked in disinfectant and squeezed dry.

Sensitive electrical or electronic equipment may be cleaned by wiping down, or disinfected by fumigation if necessary.

DISINFECTION DURING OUTBREAKS OF LIST A DISEASES

In the event of an outbreak of an OIE List A disease at a stockyard, or when such a disease has been shown to be present by disease traceback, measures are required to contain the disease and prevent spread to surrounding areas. The relevant veterinary authorities in each country – e.g. Department of Agriculture and Livestock (Papua New Guinea), Department of Primary Industries (Australia), Ministry of Agriculture (China), Ministry of Agriculture, Fisheries and Food (United Kingdom), Ministry of Agriculture, Forestry and Fisheries (Korea), Ministry of Health and Welfare (Japan) – are responsible for the control programme. This includes the slaughter of livestock, control of movement to and from the stockyard, and the instigation of a decontamination plan. Decontamination is a vital element in disease eradication and includes the
elimination of the disease agent in infected premises, to reduce the possibility of dissemination to other areas and shorten the period between slaughter and re-stocking.

In the case of a List A disease, the importance of disinfection can be assessed according to three factors: mode(s) of disease transmission, likely contamination of the environment, and susceptibility of the causal agent to disinfectants. In some cases (e.g. Rift Valley fever), diseases are spread by insects and the causal agent may be unable to survive outside the host (e.g. in contagious bovine pleuropneumonia). In such cases, disinfection might not be a suitable control method. Table I shows the potential for survival and transmission of the causal agents of List A diseases, and provides an indication of the usefulness of disinfection in each case. Although disinfection might not be indicated for the primary disease agent, secondary infections can be important, and an adequate cleaning and disinfection programme reduces the number of microorganisms in the premises. In some cases, vermin may be vectors of the disease (e.g. vesicular stomatitis) and these must be controlled at the beginning of the decontamination programme.

When the housing or pens are empty, the disinfection procedure may commence, using a disinfectant known to be effective against the microorganism involved. Lists of various approved disinfectants are used in the United Kingdom, Switzerland and Austria. In other countries, acids, alkalis and other chemicals are used. Table II lists the types of chemicals and disinfectants currently in use.

Step 1: Setting up

Extractor fans should be switched off in all buildings, particularly when diseases such as FMD or PRRS (18) are present, to prevent further airborne dissemination of the infectious agent.

In the building which is to be decontaminated, the electricity supply should be switched off to allow removal of sensitive equipment and prevent electrical accidents during wet cleaning. Alternative arrangements should be made to supply power for the necessary cleaning equipment.

As a copious supply of water is required, it may be necessary to make arrangements for alternative sources to mains water (e.g. tankers or pumping from natural sources), particularly in the case of drought, or if the mains supply is of limited capacity.

Drains and run-offs should be blocked and disinfected, and allowed to run free only when all effluent has been treated. Channels and gullies must be emptied and the contents disposed of by burying in a prepared pit.

Disinfectant solutions should be prepared in dilutions applicable to the particular infectious agent present. Disinfectants with some detergent properties should be used, if available, as these will also help surface cleaning.

Foot baths or containers with disinfectant should be set up at all entrances and exits to the building, and at other points where it is necessary for personnel to move from a contaminated area to a decontaminated area.

Disinfectant mats or wheel baths containing disinfectant should be set up at all vehicle entrances and exits.

Personal decontamination will be required to prevent operators from disseminating the disease agent. An area must be set aside at the perimeter of the contaminated premises for decontamination of personnel; this site may be moved as the
<table>
<thead>
<tr>
<th>Disease</th>
<th>Transmission</th>
<th>Survival outside the host</th>
<th>Disinfection required</th>
</tr>
</thead>
<tbody>
<tr>
<td>African swine fever</td>
<td>Contact with infected animals or materials; via ticks</td>
<td>Yes (in housing, water, feed, vehicles)</td>
<td>Yes</td>
</tr>
<tr>
<td>Bluetongue</td>
<td>Insect bites</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Contagious bovine pleuropneumonia</td>
<td>Inhalation</td>
<td>No</td>
<td>No (but secondary infection can be important)</td>
</tr>
<tr>
<td>Foot and mouth disease</td>
<td>Contact with contaminated materials. Ingestion or airborne spread of agent</td>
<td>Yes (in housing, feed, clothes, vehicles)</td>
<td>Yes</td>
</tr>
<tr>
<td>Hog cholera</td>
<td>Ingestion of contaminated feed. Contact with infected animals or materials</td>
<td>Yes (in housing, water, feed)</td>
<td>Yes</td>
</tr>
<tr>
<td>Lumpy skin disease</td>
<td>Insect bites</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Rift Valley fever</td>
<td>Insect bites</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Rinderpest and peste des petits ruminants</td>
<td>Inhalation of agent or ingestion of contaminated feed. Contact with contaminated materials</td>
<td>Yes (in housing, for a few days only)</td>
<td>Yes</td>
</tr>
<tr>
<td>Sheep and goat pox</td>
<td>Contact with infected animals or materials. Inhalation of agent</td>
<td>Yes (in housing)</td>
<td>Yes</td>
</tr>
<tr>
<td>Swine vesicular disease</td>
<td>Contact with contaminated materials. Ingestion or airborne spread of agent</td>
<td>Yes (in housing, feed, clothes, vehicles)</td>
<td>Yes</td>
</tr>
<tr>
<td>Vesicular stomatitis</td>
<td>Contact of contaminated materials with abraded skin. Insect bites</td>
<td>Yes (in housing, for a few days only)</td>
<td>Yes</td>
</tr>
</tbody>
</table>
TABLE II

Types of chemicals and disinfectants used for disease control

<table>
<thead>
<tr>
<th>Disinfectant group</th>
<th>Dilution</th>
<th>Contact time</th>
<th>Disease agent</th>
<th>Contra-indications and specific uses</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Acids</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Citric acid</td>
<td>0.2%</td>
<td>30 min</td>
<td>FMDV</td>
<td>Safe for use on clothes and skin</td>
</tr>
<tr>
<td>Hydrochloric acid (10M)</td>
<td>2%</td>
<td>10 min</td>
<td>FMDV</td>
<td>Corrosive to skin and many metals; sporicidal</td>
</tr>
<tr>
<td>Phosphoric acid (technical grade)</td>
<td>0.03-0.3%</td>
<td>30 min</td>
<td>FMDV</td>
<td>Corrosive</td>
</tr>
<tr>
<td><strong>Aldehydes</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Formalin 34-40%</td>
<td>8%</td>
<td>10-30 min</td>
<td>FMDV, SVDV</td>
<td>Releases toxic gas</td>
</tr>
<tr>
<td>Formaldehyde gas</td>
<td>5 g/m³</td>
<td>15-24 h</td>
<td>FMDV, SVDV</td>
<td>Toxic gas, requires expert handling; for use on sensitive equipment</td>
</tr>
<tr>
<td>Glutaraldehyde</td>
<td>2%</td>
<td>10-30 min</td>
<td>Effective against all types of microorganisms</td>
<td>Sporicidal; non-corrosive; needs activating before use; sensitizer; toxic</td>
</tr>
<tr>
<td>Glutaraldehyde (formulated disinfectants)</td>
<td>0.5-2%</td>
<td>10-30 min</td>
<td>Effective against all types of microorganisms</td>
<td>Sporicidal; non-corrosive; possible sensitizer</td>
</tr>
<tr>
<td><strong>Alkalis</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sodium hydroxide</td>
<td>2-3%</td>
<td>10 min</td>
<td>Effective against all types of microorganisms</td>
<td>Corrosive to aluminium; for use in presence of high concentrations of organic soiling</td>
</tr>
<tr>
<td>Sodium carbonate (washing soda) 10%</td>
<td>3-4%</td>
<td>10 min</td>
<td>Effective against a range of microorganisms</td>
<td>For use on protective clothing and skin</td>
</tr>
<tr>
<td><strong>Halogens</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sodium hypochlorite</td>
<td>2-3% average chlorine</td>
<td>10-30 min</td>
<td>Effective against all types of microorganisms</td>
<td>Inactivated by organic soiling; unstable in warm, sunny conditions</td>
</tr>
<tr>
<td>Calcium hypochlorite</td>
<td>0.05-0.5%</td>
<td>10-30 min</td>
<td>Effective against all types of microorganisms</td>
<td>Can be corrosive; contains surface-active agents which aid cleaning</td>
</tr>
<tr>
<td>Iodophors</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Peroxygens</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peracetic acid</td>
<td>0.5-2%</td>
<td>10-30 min</td>
<td>Effective against all types of microorganisms</td>
<td>Can be corrosive; for use in the presence of high levels of organic soiling</td>
</tr>
<tr>
<td><strong>Phenolics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Clear soluble black and white fluids)</td>
<td>0.5-2%</td>
<td>10-30 min</td>
<td>Effective against bacteria and some viruses</td>
<td>For use on heavy soiling; tainting, corrosive</td>
</tr>
</tbody>
</table>

FMDV: foot and mouth disease virus  SVDV: swine vesicular disease virus
decontamination procedure progresses. Operators should be provided with overalls (plastic or fabric), protective footwear, head covering, gloves and goggles. Each of these items must be decontaminated by disinfection (and dry cleaning after disinfection in the case of fabric garments) each time the operator moves from a contaminated to a non-contaminated area. A changing area with hot shower or washing facilities should be available. Buckets of disinfectant should be used to soak clothing, and plastic bags should be used to transfer disinfected articles for further cleaning if required.

The safety of all personnel on the site must be ensured. Before commencing work, each person must be made aware of the hazards involved in the use of heavy machinery, chemicals, flame guns, etc., and provided with the necessary personal protective equipment. Clear instructions must be given for each procedure.

**Step 2: Preliminary disinfection**

The disinfectant should be applied using a low-pressure sprayer such as a knapsack sprayer or a pump with spray attachment, covering all areas to damp down dust, which could spread microorganisms (particularly airborne disease agents) to other areas. This procedure should be implemented as soon as possible after the disease is confirmed. The aim is to cover all surfaces without creating pools of liquid which could run into drains.

**Step 3: Equipment**

Washable, portable equipment should be placed in a soaking bath filled with diluted disinfectant and left to soak. Fans and shafts should be opened to allow cleaning.

Sensitive equipment should be removed to a separate area for cleaning and disinfection, while sensitive equipment which cannot be moved (e.g. electrical switchboards) should be protected.

Equipment used to apply disinfectants – e.g. manual equipment such as brushes and scrapers – as well as mechanical equipment such as diggers and tractors, and personal equipment such as cameras will all require decontamination after use. Pumps, pressure washers and mechanical equipment may be sprayed and washed, while smaller items may be soaked and washed.

Sensitive equipment should be used inside plastic bags (to prevent gross contamination) where possible, and wiped down with disinfectant after use.

**Step 4: Removal of gross soiling**

Manure, soiled bedding and unused feed should be removed by using a manual or mechanical scraper. Under-floor areas and lofts above false ceilings must also be cleared. Debris should be disposed of away from the building by burning or burial.

Old insulating material (polystyrene, fibreglass), if this is not in a sound condition, should be removed for burial or burning. Rotten wooden fittings, posts and flooring should also be removed for burial or burning.

Where earth floors are present, the top layer of manure and debris should be removed. The firm earth underneath should then be dug out to a depth of approximately 3 cm, and the earth broken up and soaked with disinfectant or caustic soda.

**Step 5: Cleaning**

Hot water with added detergent, degreaser or detergent-disinfectant should be applied through a knapsack or backpack sprayer, or pressure washer, starting at the apex of the building or the top of the pen and working downwards to the floor and then across
to the drain. If necessary, caked-on soilage should be removed manually, paying particular attention to inaccessible areas such as fan shafts and waste feed ducts. Outside areas should also be cleaned, paying particular attention to ventilation and fan inlets.

**Step 6: Water system**

The water system should be drained (if possible) by isolating the header tank and draining off from points furthest from the tank. The tank should be cleaned, removing any sludge, and refilled with clean water. Disinfectant should be added and allowed to stand for a minimum of 10 min. This should then be flushed through to the drain-off points and left for 30 min. The tank should be refilled with fresh water and the system flushed through once more. If it is not possible to drain off the system, the tank should be isolated, allowed to run dry and then cleaned. Dirty water should be washed away by hosing down.

**Step 7: Disinfection**

The building should be inspected visually and, if visibly clean, allowed to dry. Step 5 should then be repeated using disinfectant at the appropriate dilution applied through a sprayer. If necessary, cleaning should be repeated to remove any stubborn soilage before continuing with disinfection. Outdoor concrete areas and the outside of air inlets should be disinfected using a knapsack, backpack or pump sprayer.

**Step 8: Drying**

The building should be allowed to dry. Covers should be removed from electrical switches or other fittings into which water may have entered, and these should be allowed to dry. Equipment should be replaced and the building sealed if fumigation is to be undertaken.

**Step 9: Flaming**

In outbreaks of some diseases (e.g. swine vesicular disease), a flame gun may be used on outdoor concrete, brick or metal surfaces after disinfection. The surfaces should be wet before starting, so that flamed and unflamed areas can be easily distinguished by the operator. A flame gun may be used only where no combustible materials are present. Disinfection and flaming should be repeated after fourteen days or other specified period.

**Step 10: Fumigation**

Fumigation (5) may be required as an extra precaution when dealing with very persistent infectious agents (e.g. FMD virus). Fumigation can only be performed where it is possible to seal the building completely, and requires considerable care if it is to be performed safely and correctly.

Fumigation is also suitable for use with sensitive equipment. The equipment should be fumigated inside a plastic tent or in a small sealable area.

Empty silos can also be fumigated if required, depending on the construction.

**Use of formaldehyde**

The activity of formaldehyde is greatest when vaporised in an atmosphere of high humidity. Generation of formaldehyde using the reaction between potassium permanganate and formalin releases water vapour, thus increasing the humidity. However, if formaldehyde is generated by heating paraformaldehyde, a separate means of increasing the humidity is required (e.g. by using an aerosol generator), but no free standing water should be present (formaldehyde dissolves in water and loses its
activity). In cold conditions, the building should be warmed to 15°C before fumigation, particularly if the roof is poorly insulated. Fluctuating temperatures can cause polymerisation of formaldehyde on cooler surfaces, leading to reduced efficacy.

*Generating formaldehyde from paraformaldehyde*

Formaldehyde may be generated from paraformaldehyde using electrically-heated pans designed for the purpose. At least 5 g of paraformaldehyde is required per m³ of air space. Up to 0.5 kg paraformaldehyde can usually be placed in each pan, and pans should be spaced not more than 30 m apart. Pans should be connected to the nearest power supply points and switched on by an operator, who should then immediately leave the building. Gas will not be liberated until the pan has had time to heat up.

*Generating formaldehyde by adding potassium permanganate crystals to formalin*

A sufficient number of metal or earthenware (not plastic) containers should be used to avoid the necessity of using more than 1 l of formalin in each container. To prevent the reactants from boiling over, the containers should have deep sides at least six times higher than the depth of formalin used. As an additional safeguard against spillage or overflow, each container should be placed on a lipped metal tray or vessel with sufficient capacity to contain the whole of the reactants.

Because of the potential fire hazard, containers should never be placed on surfaces which are combustible or sensitive to heat. For example, if the building has wooden floors, the containers should be placed on bricks or other inert supports. At least 2 m clearance must be allowed between the tops of containers and any combustible material.

Where several containers are required, these should be distributed evenly along the length of the building. The potassium permanganate crystals should be weighed out in advance into small glass or metal containers (not paper, cloth or fabric). The formalin is then measured into each reaction vessel. Before adding the potassium permanganate, the access door to the building should be securely fixed open. All other entrances to the building should be locked and sealed, and warning notices displayed on all doors stating that toxic gas is present inside.

It is essential to add the potassium permanganate crystals as quickly as possible, as the formaldehyde vapour is produced almost immediately on contact. During this operation, the operator should wear a full-face respirator fitted with the appropriate canister for formaldehyde. A second person with similar protection should watch the operation and be ready to help in case of accident. Starting with the container furthest from the door, the operator should stand well back and, without bending over the container, carefully pour the previously weighed potassium permanganate crystals into each vessel in turn, working towards the exit. As soon as the operator has completed the task and left the building, the door should be locked and sealed.

The building should be left sealed for 24 h and then thoroughly ventilated before re-entering. Alternatively, formaldehyde can be neutralised by ammonia gas (7.5g/m³) after decontamination. This can be produced by heating ammonium carbonate to 120°C in electrically-heated pans.

The remains of the reaction mixture in the vessels will still have oxidising properties and must not be allowed to come into contact with organic material such as paper, straw or wood shavings. The residue should be mixed with water and the resulting slurry buried or washed down a drain.
Detectable quantities of a potent lung carcinogen may be formed when high concentrations of formaldehyde gas are mixed with chlorine-based disinfectants. Particular care should therefore be taken when chemicals containing chlorine (e.g. hypochlorite) are present.

**Step 11: Re-stocking**

When all procedures have been completed, animals can be re-introduced after the specified waiting period. It is advisable to introduce sentinel (susceptible) animals first, to monitor the effectiveness of the decontamination.

**CONCLUSIONS**

With increasing trade in animals and animal products, the likelihood of disease outbreaks becomes greater. In countries (e.g. Australia) which are currently free from many of the most serious diseases, the economic losses from an outbreak of foot and mouth disease, for example, would be catastrophic. Stockyard personnel must be vigilant in implementing control programmes, as stockyards are potentially major centres for the dissemination of disease. The programmes described above, which may be adjusted to suit particular circumstances, form the basic requirements of a good hygiene system, which is essential in the control of disease.

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**DÉSINFECTION DES PARCS À BESTIAUX. – V. J.C. Fotheringham.**

Résumé : Les parcs à bestiaux sont des locaux où du bétail provenant de diverses exploitations est regroupé pendant un certain temps avant d’être réacheminé soit vers l’élevage d’origine, soit vers de nouveaux locaux, soit à l’abattoir. Ces parcs posent des problèmes sanitaires particuliers car ils constituent une source potentielle de dissémination d’agents pathogènes sur de vastes zones géographiques. L’auteur décrit un programme complet de nettoyage et de désinfection destiné à l’entretien de routine de ces locaux d’élevage. Il présente également un autre programme applicable en cas de maladie inscrite sur la Liste A de l’Office international des épizooties, qui prend en considération les risques supplémentaires liés à ce type d’épidémie.

Resumen: Los cercados para el ganado son recintos en que se reúnen animales provenientes de diversas explotaciones durante un tiempo antes de ser encaminados al lugar de origen, a nuevos locales o al matadero. Estos recintos plantean problemas sanitarios específicos en la medida en que constituyen una fuente potencial de diseminación de agentes patógenos en regiones geográficas extensas. El autor describe primero un programa completo de limpieza y desinfección para el mantenimiento de rutina de los cercados para el ganado, y a continuación un programa aplicable en caso de presentarse una de las enfermedades inscritas en la Lista A de la Oficina internacional de epizootias, teniendo en cuenta los riesgos adicionales inherentes a los brotes de ese tipo.


REFERENCES


