Effective use of disinfectants in disease prevention and control

Cleaning and disinfection is not only part of an avian influenza prevention strategy, it should prevent any disease. Moreover, a good sanitation programme will improve production results, so it is economically very important. It should be perceived as an investment, rather than as a cost.

by Luc Ledoux, Business Unit Manager, CID Lines nv, Belgium. www.cidlines.com

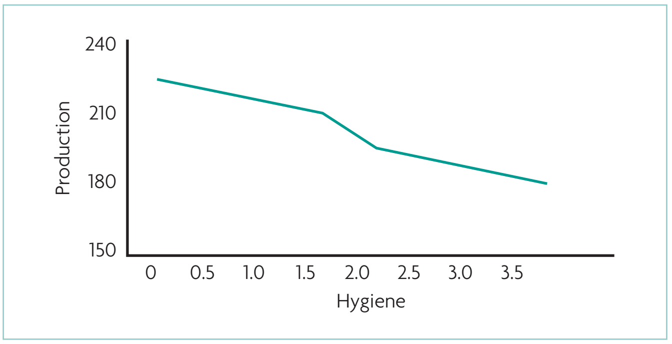


Fig. 2. The correlation between hygiene and production results.

Rule number one is: disinfection is impossible without cleaning first; you cannot disinfect dirt!

This should be applied in all links of the production chain: hatchery, trucks and farm. On farm, it applies not only to the house itself, but also to people (boot dips, hand hygiene, showers), crates, drinker lines, to feed and to drinking water. Hence, cleaning and disinfection forms a part of 'bio-exclusion' (keeping disease agents out). But, it does not end at the processing plant; it continues in the store and at home until the preparation of the meat. Biosecurity is a programme 'from farm to fork'.

Is hygiene important?

Hygiene and disinfection are partially overlapping notions. Hygiene is mainly related to cleanliness, to the management of dirt, but also in its microbiological sense.

'Sanitation' means to improve the hygienic circumstances. Terminal disinfection is strictly about eliminating possible pathogen micro-organisms by reducing them as close to zero as possible (or by a maximum log).

Both are actions aimed at removing possible causes of contamination that can affect your chick quality. Let's call the cleaning part 'macro' and the disinfection part 'micro'.

The macro part is the bulky part, that is mainly visible to the human eye. On the organic side, we can see the litter, the excrement, the contents of broken eggs, the fluff and meconium of day old chicks, and we know they contain micro-organisms.

On the inorganic side, we see the lime scale build up, caused by calcium (or other mineral) deposits of hard water. We know they can equally shelter micro-organisms.

So we can see if the organic and inorganic dirt has been removed and assume a lot of micro-organisms have gone with it. This is the cleaning part.

The question is, how many pathogens remain after the dirt has been removed? A rule of thumb in the hygiene industry is that a good cleaning job should remove at least 85% of the micro-organisms. So we consider 'sanitation' as a good cleaning job, not as a good disinfection job.

A good cleaning job will determine the microbiological result for ›85%. The disinfection will contribute only ‹15%, as the 'cherry on the cake'. A bad cleaning job means that dirt (organic or inorganic) will still harbour micro-organisms that the disinfectant cannot reach.

The micro part is the abstract part. It is the fight against an 'invisible enemy'. We need to visualise this enemy through electronic microscopes or, in the case of bacteria and fungi, incubate them to become visible Colony Forming Units.

The HACCP (Hazard Analysis Critical Control Points) standard for disinfection is to reduce the micro-organisms by 99.99% or log 4. (Sterile is a 100% reduction and is required in certain surgery circumstances, for example). A good hygiene programme will also include operational or managerial measures to prevent contamination or to secure the health (and the life) of your livestock, be it breeders, hatching eggs or broiler chicks. Securing life (or 'bios' in Greek) is what biosecurity stands for.

Biosecurity is often defined as: 'measures designed to protect a population from transmissible infectious agents'.

Components of biosecurity

Biosecurity has three components: isolation (all in/all out), traffic control and sanitation (or cleaning and disinfection). The goal is to break the chain of infection. This chain is composed of pathogens that need a reservoir or source (people, other birds, rodents, insects or any organic material acting as life support for those microbes, say 'dirt') and that can get transmitted to (other) birds (the 'target'), again becoming a source for further transmission, etc.

The best way to avoid infection is obviously to have the environment (the incubator, the truck, the barn) free of disease-causing organisms.

This can only be achieved by thorough cleaning and disinfection (eliminating the original reservoir or source).

Bacteria can double by cell splitting every 20 minutes, so one bacteria can reproduce in less than a day to a number far greater than the number of people on earth (seven billion)!

Downtime is not possible in the

Fig. 1. The chain of infection.

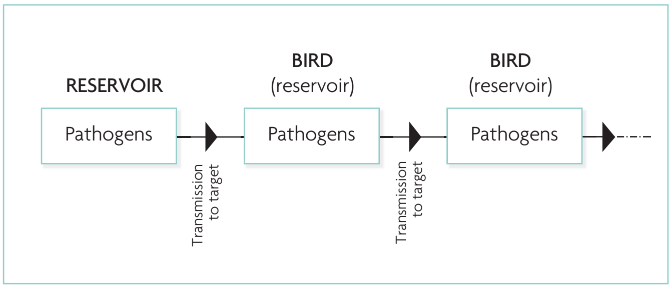


Table 1. CFU reductions at North Carolina State University test farms.

House status	CFU/sq	Reduction from previous step (%)
Dirty	3,000,000	–
Blown down (air)	2,900,000	3.4
Air out	2,000,000	31
Washed with water	500,000	75
Washed with detergent	100,000	80
Disinfected	‹1,000	›99

Characteristics of detergents	
Wetting:	decreases surface tension
Dispersing:	splits up dirt particles
Emulsifying:	splits and suspends oil and fat
Suspending:	floats and carries away dirt particles
Sequestering:	dissolves salts

Table 2. Characteristics of detergents.

hatchery, so more stringent measures will be needed there. Even if you set eggs in 'single stage' (all in/all out, allowing to clean and disinfect the setters every 18 days in the case of chicken incubation) the hatchery as a whole will always be a 'multi stage' operation.

There is a matrix of different sources of contamination: vertical, horizontal, internal (within the house) and external (from outside vectors such as people and their vehicles).

Vertical transmission means that the infection has been transmitted by the parent stock through the hatching egg. Hence the importance of starting with a healthy breeder flock as a first premise for biosecurity. The breeder's health status should be maintained, so they should be protected from horizontal contamination, both internally and externally, which is basically the same principle as in the case of broilers (farm hygiene).

So, are cleaning and disinfection important?

Studies at the Institute of Poultry Research in Holland have shown that the better the 'hygiene score', the better the 'production figure', as shown in Table 1.

The hygiene result is according to the Dutch IKB or ICC (Integrated Chain Control) standard:

- 0 = 1-3 CFU.
- 1 = 4-9 CFU.
- 2 = 10-29 CFU.
- 3 = 30-90 CFU.
- 4 = >90 CFU.

The production result is the EPF (European Production Figure) calculated as follows : ((Growth (kg) x survival rate) / FCR) x 100).

Cleaning first

Cleaning is the removal of dirt. A study at North Carolina State University stresses the importance of using detergents (and disinfectants afterwards). So, what do those detergents do to make the surfaces cleaner?

Table 2 shows the 'chemical' action of detergents. The action will also be determined by the pH. If the dirt is organic (fat, proteins, manure that is acidic) then an alkaline (pH>8) detergent will be needed. If the dirt is inorganic (lime scale from calcium or any other mineral deposit, that are alkaline), an acid (pH <6) detergent will be needed.

In total, there are four factors of cleaning:

- Chemical energy: pH and concentration, (alkaline detergents remove proteins and fat; acid detergents remove mineral deposits like scale).
- Thermal energy: fat starts to dissolve as from 35°C or 95°F.
- Physical energy: a high pressure washer (forget the broom; too tiring for operators).
- Contact time: this will enable the chemical energy to do its job. Moreover, it is the only factor that does not cost any energy, it is free of charge.

If you increase one factor, you can save on the others. Since contact time is free of charge, this is the one we should maximise, in order to save water consumption, labour and energy, as shown in Fig. 3.

Disinfection

The goal of disinfection is to reduce the number of pathogens, ideally by log 4 (99.99%). Therefore, the disinfectant should comply with a number of characteristics. First of all, it should be compatible with the detergent, foam or gel cleaner. This means that if your cleaning agent contains cationic surfactants (= ions having a positive charge), your disinfectant should not contain anionic surfactants (= ions having a negative charge). Phenols and especially their derivate like cresols are known not to be compatible with nonionic surfactants and cationic ones like quaternary ammonia.

Well formulated disinfectants should comply with a number of characteristics, such as COST – Composition, Opportunity, Safety and Tested.

Composition

How many different active ingredients compose the product, so that it assures a maximum synergy?

Does the product contain buffering agents (surfactants, wetting agents, sequestering agents, stabilising agents) so it works in contact with organic matter, in hard water, in cold water, in all pH, and assures a minimum two year shelf life in concentrate and several weeks in dilution?

The million dollar question: How many grams/L (oz/gal) or % active ingredients does the product have? And, is it expressed in terms of 100% ingredients (glutaraldehyde is sold in 50%: this amount should be halved to express the total number of gr/L glutaraldehyde); or in other words: how much water is there in the drum?

This concentration will determine the dilution. Unfortunately, we have seen disinfectants on the market that do not disclose their concentration of active ingredients. In this case, the customer is buying his 'wildest guess' and has no idea how much water there is in the drum.

Opportunity

Does the product have the full spectrum: bactericide, fungicide, virucide and sporicide?

Beware of 'statics', like bacteriostatic: they stop their development, but do not reduce their number.

Is it also versatile to be sprayed, foamed and fogged without any extra additives. Is it ready to use?

Safety

It is important that the product is safe for:

- The people (not containing carcinogenic substances like formaldehyde; complying with the Maximum Exposure Limit or MEL, with CLP, with REACH).
- The animals.
- The equipment (not corrosive on galvanised feeder lines and fans, or aluminium drinker supports).
- The environment (biodegradable and therefore not containing heavy metals such as tin, silver).

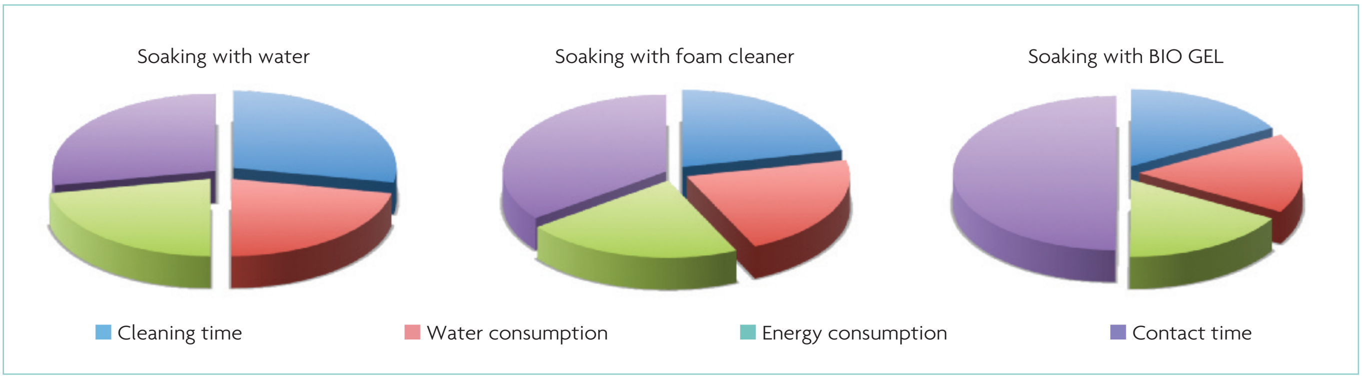
Tested

By international standards such as the ENE (European Norms-Normes Européennes) and the American AOAC (Association of Analytical Chemists, that work with 5% organic load and in 400ppm hard water) rather than only national standards (such as DEFRA, DVG, Afnor) that have been or may be replaced by the ENE.

The disinfectant should be 'full spectrum' (with proven efficacy on bacteria, virus and fungi) and be tested against at least one HPAI virus strain.

This acronym (COST) is more relevant than the perceived cost: the price per litre (per gallon) The real cost is the cost in dilution, determined by the concentration and the synergy. ■

Fig. 3. The effect of increasing contact time on water consumption, labour and energy.



Effective use of disinfectants in disease prevention and control: II

With the exception of cases involving ovarian infection, the hatching egg is free of micro-organisms when it leaves the oviduct. This presumes a clean cloaca, that is not affected by diarrhoea, since wet droppings will contaminate the shell.

by Luc Ledoux, Business Unit Manager, CID Lines nv, Belgium. www.cidlines.com

Then it may face many challenges. If the egg is laid in the nest (floor eggs and eggs laid on slats are 'dirty' by definition), a dirty nest or litter will immediately contaminate the egg, as will dirty egg belts in the case of mechanical or automatic nests. Thus, eggs laid in nests or transported on belts contaminated with droppings, broken eggs, wet shavings etc may be as contaminated as floor eggs are, or even more.

Next, non-sanitised hands may put them on contaminated flats, trays or cartons. The egg storage room in the breeder farm also stores many micro-organisms as does the truck that brings them to the hatchery. Once there, they may again be contaminated. Moreover, a 'rough ride' to the hatchery can cause cracks in the shell, that allow for an easier bacteria penetration and affect hatchability. Needless to say, the vehicle transporting the eggs should be clean and disinfected.

In addition to all that, other biological vectors such as insects, rodents or wild birds can contaminate the eggs should they be in contact with them.

Last but not least, wide temperature changes can make the eggs sweat, which allows rapid multiplication and easier access of micro-organisms to the highly nutritious egg content.

So, there is room for hygiene measures at each of the above 'critical control' points. In addition, frequent egg collection will help reduce contamination (and 'spontaneous incubation' in hot climates).

As a summary, the precious hatching eggs are at risk from:

- External contamination of the shell and through pores and hairline cracks.
- Vertical transmission (from infected flocks).
- Internal contamination (of yolk and albumen).
- External vectors such as hands, trays, vermin, transport equipment, etc.

Nature provides the egg with some natural barriers such as the cuticle, the calcium carbonate shell (with up to 17,000 pores), the two shell membranes, and chemical defences within the albumen.

The cuticle is a physical barrier to micro-organisms, but it can be removed by improper washing products and procedures or by rubbing the egg. The shell thickness and pore length will determine the resistance of shell penetration.

Bacteria will penetrate thin shelled eggs (from older flocks) more easily. Calcium should be added to the feed of breeder hens, but be sure that enough calcium is absorbed in the metabolic process to ensure a strong shell formation.

Hens with diarrhoea will not absorb sufficient nutrients and calcium, and more will be excreted. Chemical sanitisers will reduce the microbial population on the shell at the time of application.

However, if micro-organisms have already invaded the egg, it is too late; the sanitisers will be ineffective.

Egg washing or not?

An egg can appear clean, but can carry over 100,000 micro-organisms on the shell surface. A test conducted by the Institute of Poultry Research in Beekbergen, Holland, indicated that mechanical egg washing can reduce the counts to 50 per egg. 'Nest clean eggs' are generally accepted as having less than 10 CFU bacteria and <5 fungi/13cm².

Washing only dirty eggs is not the total answer, as clean eggs can be re-contaminated in the setters by bacteria from the un-washed eggs which appear clean.

Dry cleaning hatching eggs, e.g. with paper, will remove the cuticle that protects them and is therefore not advisable.

The University of Athens, Georgia (USA) reports that 'the difference in hatchability between nest clean and dirty eggs was due to higher embryonic mortality following transfer into the hatcher of dirty eggs'. So, washing dirty hatching eggs is not a luxury after all.

The biggest problem with egg washing (and disinfection) is that there should be proper temperature and concentration control.

Hatching eggs can be washed with alkaline products (based on potassium hydroxide), to remove mainly fat and protein, which can be either chlorinated or non-chlorinated. Proper temperature control (42-45°C or 108-113°F) is crucial.

The water should be warmer than the egg contents throughout the cleaning cycle. This will result in a positive pressure in the egg, causing the inner membrane to expand against the shell to help prevent anything from entering the egg. Contact time should be limited to approximately five minutes, in order not to damage the cuticle. The washing machine should be temperature and concentration controlled (automatically stopping when either are not optimal).

Disinfection afterwards should be at a slightly higher temperature, to prevent the product from entering the pores (45-47°C or 113-117°F); after rinsing at the same temperature. Use only disinfectants chemically compatible with the cleaning product. There must be no conflict between the surfactants in the cleaning product (anionic surfactants neutralise cationic).

Use only recommended disinfecting products at the correct concentration or penetration of the cuticle can occur. Ideally, a disinfectant with a residual action should be used, to prevent early re-contamination. This is not the case with formaldehyde fumigation (that does not kill the spores of Aspergillus fumigatus neither).

Fogging of hatching eggs with a QAC/glut based disinfectant has shown, based on large scale trials (done by CID LINES on 9.7 million broiler hatching eggs) that there are alternatives to formaldehyde fumigation, that have at least the same CFU reduction (actually better) and did not affect hatchability. The key is to have the right nozzle, with the correct droplet size.

Table 1 gives a summary of the major actions to be taken.

Nest hygiene	Clean nests and belts, regularly disinfected
Egg collection	With clean hands and flats, regularly disinfected
Egg storage in farm	Cool (around 18°C/65°F) in a clean and disinfected area
Egg transport to hatchery	In a cleaned and disinfected truck, with good (air) suspension
Egg storage in the hatchery	Cool (around 18°C/65°F) in a cleaned and disinfected egg room
Egg handling in general	Carefully, not causing cracks

Table 1. Hatching egg hygiene before setting (eggs from a healthy flock).

Setters and setter room biosecurity

Obviously, single stage setters allow for a thorough clean out and disinfection after every 18 days.

Nevertheless, a setter room with single stage setters is still a multi-stage operation that normally never stops running. There are eggs from many flocks, there are embryos in different stages of development. So even in a setter room with single

Continued on page 22

Continued from page 21

stage incubators, cross contamination from setter to setter may occur if air can flow from one setter to another.

The setter room is considered the 'clean zone' (provided the eggs have been disinfected prior to setting). However, exploders (often caused by Pseudomonas) can cause serious contamination. They are the biggest threat of the clean zone in the hatchery.

The incubators not only incubate embryos, but also many bacteria. In multi-stage setters, this growth of bacteria is uninterrupted, unless regular spray or mist disinfection is carried out and exploded eggs are removed and their debris is cleared up. Fumigation in the setter with formaldehyde, a carcinogenic product, cannot be done between 24 and 96 hours of embryo development. Moreover, formaldehyde has no residual action so does not prevent recontamination.

Remember that bacteria can double every 20 minutes. Table 2 shows what bacteria need for growth and how we can reduce this growth.

Food	Yolk and albumen	Remove waste, keep clean
Water	In egg and via humidifier	Avoid leakage, treat water
Temperature	In incubator	Store eggs in cool, and clean area
Shelter	In eggshell, fittings, ducts	Clean and disinfect eggs, rooms, machines and equipment
Air	Ventilation of machines and building	Spray or fog in machines, mist in rooms, renew air filters

Table 2. Bacterial needs, sources and solutions.

Floors, walls and setters can be washed with a 'universal' cleaner, designed specifically to remove the typical debris of the 'clean zone' (yolk, albumen, blood).

This detergent should also be suitable for application with a foam lance or scrubbing machine and therefore have good adhesion. In the case of hard water, it is advisable to alternate once per month with an acid foam to descale surfaces.

A good foam formulation will cling to ceilings and vertical surfaces, allowing a longer contact time for the chemical to act.

The terminal disinfection should also be versatile enough to be applied by spraying, foaming and fogging. Room fogging (or misting) in the setter (and hatcher) rooms allows the product to enter the machines through the air inlets and to disinfect the incubators at the same time.

Hatcher and hatcher room biosecurity

In the dirty zone (hatcher room, chick room, wash room, reception and storage of dirty boxes), stronger cleaning products are advised; especially for cleaning the hatchers and plenums, where lots of fluff needs to be removed, (salmonella can live for years in fluff).

An alkaline foaming detergent, or even better an alkaline gel with higher viscosity will do the job properly. Instead of relying on 'elbow grease', it is better to rely on the chemistry of specially designed products, allowing for a long enough contact time and thus saving on water consumption, energy costs and cleaning time. Again, it is advisable to rotate on a monthly basis with an acid foaming detergent. Especially in the dirty zone, it is important to follow the correct procedures:

- Remove all visible debris manually (with shovel and brush).
- High pressure wash with (foaming) detergent (by foam lance).
- Rinse.
- Allow to dry.
- Disinfect.

Often, step four is forgotten. When the disinfectant is sprayed on a wet surface, it may become diluted more than it should. Moreover, the surface tension of water that is still present in cracks and holes will impede good penetration of the disinfectant solution (even if it does contain surfactants). A well formulated product with good surfactants will penetrate dry cracks more easily.

You will have noticed that there is no need for rinsing the disinfectant from the hatcher cabinet. When the product has a residual action, you can simply spray, or (even better) foam it on all surfaces, load in the transferred eggs and close the doors. The product will keep on working throughout the hatching process as long as it does not evaporate.

The germ counts increase logarithmically when the chicks start pipping. Excellent field results have been observed by fogging a QAC/glut based disinfectant in hatcher cabinets, compared to formalin.

The use of a 'plenum' or 'fluff tunnel' behind the hatchers (equally to be cleaned and disinfected after every hatch) avoids fluff re-entering other machines or just flying around. Hence the importance of negative pressure in the 'dirty area'.

Chick room and wash room biosecurity

Automation equipment can be washed and disinfected like the hatchers.

Trays, crates and baskets can be washed with alkaline detergents, eventually chlorinated (which will sanitise them and bleach white baskets). It is important that the products do not foam when washing through tunnel machines. If the temperature drops (near the end of the cycle) proteins will cause the formation of foam. So, temperatures should be high enough to remove the organic matter (60°C and more or 140°F and more) but not so high as to damage the plastic (as of 90°C or 194°F) and not too high to neutralise the chlorine in case of chlorinated tray wash either.

Ideally, these alkaline products which remove mainly fat and proteins should be rotated with an acid, non-foaming detergent to remove mineral deposits (limescale, iron), egg shell residues and residues from the alkaline cleaners.

The acid product will unblock the nozzles and de-scale the inside of the tunnel washer. However, it is advisable to disinfect the interior of the tunnel washer by spraying and even to wash your washer regularly.

Hatcher baskets and chick boxes should be disinfected immediately after washing by spraying. If setter trolleys and trays go back to the farm, they must be disinfected. If farm buggies are being used, they should equally be disinfected.

When a vacuum waste removal and silo system is not available, the offal containers also need cleaning (with a universal detergent) and disinfecting afterwards.

Vehicle biosecurity

Vehicles transporting hatching eggs, day old chicks, feed, broilers, manure and meat are crossing all over the place worldwide.

Vehicles are 'mobile vectors': they can bring contact between the 'source' (the reservoir) and the 'target' (the bird or the egg) and get contaminated 'on the road'.

Trucks should have been washed (inside and outside) and disinfected after every delivery, whether it is hatching eggs, chick, broilers or feed transport. A slightly alkaline, foaming truck shampoo should remove the outside 'traffic film' (a build up of dust, grease, petroleum and exhaust residues, dead insects) and the same product for cleaning the setter can be used for cleaning inside the vehicle. This product should not be corrosive (and definitely not contain chlorine or be too concentrated on sodium hydroxide that corrode aluminium).

Ideally, the truck shampoo should be applied as a foam, starting from the bottom and going up with the lance. Wash vehicles in the sun should be avoided.

After cleaning, the vehicle should be rinsed off. Start at the bottom, going up and move the pressure lance from left to right. Apply a final rinse from the front towards the end, to remove the remaining foam before disinfecting.

The disinfectant should obviously be not corrosive (it should ideally have been tested by an automotive organisation) and it should equally work in cold temperatures where they occur.

Livestock transport has often been defined as the primary disease vector, such as in the recent AI outbreaks on three continents and in the FMD outbreak in the UK some years ago.

Often, critical places are forgotten, such as the underneath of the vehicle, the inside of the wheel arches and the driver's cabin (livestock trucks are usually not designed to be easily cleaned).

Equally important is the replenishment of farm gate wheel dips. Last but not least, we have observed wheel disinfectant pads that were smaller than the circumference of the vehicle's wheels.

Automatic spraying installations, reaching the underneath and the arches deliver a better job. They also assure 'fresh' disinfectant to be used. But they cannot operate when freezing.

When freezing, manual disinfection is required. Eventually, a glycol mixture (a good anti-freeze agent) can be added to the water to dilute the disinfectant, provided the disinfectant is compatible with glycols.

If plastic chick boxes are used, they usually go back to the hatchery. There, they can be washed (and disinfected) in the tray washing machine (tunnel). The same procedure is required as for hatcher trays.

The other vector are obviously the crates in which the broilers are being transported to the processing plant.

Research on 72 containers which had been used for transporting 12 flocks has shown that broilers leaving the farm salmonella free, can be positive when arriving at the processing plant.

Farm biosecurity

Apart from rodent control and insect control (to be done immediately after bird removal), we will strictly focus on cleaning and disinfection.

Procedures

The Dutch ICC (Integrated Chain Control) system describes the procedures for poultry houses as follows:

- Remove litter, empty drinkers and clean dry all visible dirt.
- Wash down with a cleaning agent and allow for enough contact time (20 minutes) and clean drinker lines (and flush them afterwards).
- Rinse and let dry.
- Disinfect (by spray or foam; foaming will visualise better where the product has been applied and stays longer on vertical surfaces and ceilings, allowing for a longer residual action).
- Install new litter, re-install and fill the feeders and drinkers.
- Do a terminal disinfection by (thermo) fogging. Do a continuous disinfection of trucks (wheel dips), people (hand hygiene, foot dips) and drinking water.

In some countries, like the USA, the reality is far away from this concept and litter is used time and time again, sometimes called 'dirt floors'. But then again, the University of Georgia writes: 'Because most US broiler houses have dirt floors, Clostridium perfringens has the opportunity to flourish and cause physiological problems to the birds, high flock mortality rates and financial losses for the farmer and the poultry company'.

A clean out and disinfection of the feed silos is equally advised. With foot dips, regular replacement of the disinfectant is important and washing the boots first!

Product characteristics

The cleaning agent should be alkaline and ideally applied as a foam, allowing for better contact time. It should also be chemically compatible with the disinfectant (anionic surfactants neutralise cationic ones).

Drinking water treatment

The FAO recognises that water contaminated with faeces from infected birds is an important source of infection of AI. Surface water (from rivers, ponds) is unacceptable unless it is properly treated. Open header tanks (where wild birds and rodents have access to) is as bad. Even if your water quality is acceptable at source, it can still be contaminated in the lines because of the biofilm. The further towards the end, the more risk of microbial contamination.

Cleaning of water lines means removing the scale and the biofilm. The biofilm is a polysaccharide layer, caused by adding vitamins, medication etc. through the water. It harbours mainly enterobacteria (salmonella, E. coli) but also virus like AI. It impedes the good functioning of medicine, vaccines, etc. It will, as scale, block the nipples and reduce the water flow. Chlorine (that gets neutralised by organic matter) will not remove the scale and not even penetrate the biofilm.

Moreover, the efficacy of chlorine depends on the pH. NaOCl dissociates in water into hypochlorous acid (HOCl) and hypochlorite ion (- OCl) . Only the first one is really effective (80-300 times more) and fast (100 times faster) at killing bacteria (the negative charge of OCL- creates an obstacle to penetrating the cell of a micro-organism).

Maximum efficacy is obtained at pH 5 or lower, because the lower the pH, the more HOCL is available. Moreover, the lower the temperature, the less HOCL there will be.

'Total chlorine' is the sum of free chlorine (HOCl plus OCl-) with chloramines. Free chlorine is not considered effective unless it is 85% hypochlorous acid, which means the pH should be under seven at all times.

Removing the biofilm is only possible by oxidation. Stabilised hydrogen peroxide will do the job. And, if the product does not contain heavy metals (like silver), it can also be given during production until the last day, avoiding a new build up and sanitising the drinking water, provided it has the proper registrations (PT 5 in Europe).

Its efficacy is hardly affected by the pH, and when its stabilised, it will reach the end of the line.

Stabilised H2O2 works in seconds. All this without leaving residues in the meat or eggs: it dissociates in H20 and O2, two natural elements. Even in 'favourable circumstances' (low pH, no organic matter, no minerals) chlorine will still need 10-15 minutes contact time at 0.1-0.2mg/L to kill bacteria and needs a higher concentration (0.3-0.5mg/L) and 30-45 minutes to kill viruses.

Chlorine may leave residuals such as THM (Tri Halo Methanes) described as 'possible cancer causing agents'. Moreover, organic matter makes it lose its microbiocidal properties, so it can no longer act as a disinfectant.

Conclusions

In this article, and in part one, which was published in International Hatchery Practice Volume 31 Number 2, we have followed the embryo from the breeder farm through the hatchery, to the farm.

Every phase needs an integrated biosecurity approach with different products and different procedures. But there, it is not over.

The stringent rules of processing biosecurity, storage biosecurity, transport biosecurity and biosecurity at the processing plant and during transport and storage in the shop will have to be implemented as well. Always pay attention to the four V's: visitors, veterinarians, vehicles and vermin.

Last but not least, basic hygiene rules will have to be implemented to take the piece of poultry meat home or to the restaurant, to store it and to prepare it.

Chicken is safe, as long as it is cooked.

The AI virus can live:

- Endlessly in frozen chicken meat.
- 1 month in cooled meat.
- <2 hours at >56°C.
- <10 minutes at >60°C.
- <1 second at >88°C.

When sufficiently cooked, other micro-organisms, such as salmonella, will be eliminated as well. When prepared in a biosecure way, chicken is a safe meal. ■