Learning from the shape and texture of hatching eggs

49

By Marleen Boerjan, Director R&D,, Pas Reform Academy

Eggshell is a well organised structure, arranged in a matrix of organic matter (proteins) and a palisade layer of crystalline calcium carbonate columns.

Between these columns, funnel-shaped openings, pores, are formed, which facilitate the exchange of gas, including water vapour, during the development of the embryo. The outer surface of the shell is covered by a waxy cuticle that protects the eggs from dehydration and invasion by micro-organisms.

From arrival in the shell gland, it takes approximately 20 hours for the egg's shell to form completely. Albumen and shell membranes have developed while the yolk, with its embryo (blastoderm) on top, travelled through the magnum and isthmus, in the upper part of the hen's oviduct.

The shell gland is the part of the oviduct that secretes a highly concentrated solution of different minerals: calcium chloride, sodium bicarbonate, sodium chloride, potassium chloride and proteins. Shell formation begins with the precipitation of calcium carbonate crystals and glycoproteins on the outer shell membrane.

Calcium carbonate crystals are deposited at a constant rate of about 0.33 g/h. To facilitate smooth, regular shell formation, the egg rotates in the shell gland. Any disturbance of this rotation, for example when the female encounters an aggressive male during mating, produces abnormally formed shell. The shape and texture of the shells is therefore a good reflection of the health and well being of the breeder flock.

This understanding is valuable to hatchery managers, not only to help evaluate the quality of the eggs delivered to the hatchery, but also to have valid input into discussions with breeder farm managers about ways in which to improve hatching egg quality. It is important to remember the influence of flock age on egg (shell) quality. Older flocks lay larger eggs with thinner shells – and the number of misshapen shells increases.

Poor hatching egg shell quality often results in increased weight loss and decreased hatchabilities, with an increased risk of cracks during handling leading to dehydration and contamination.

Broadly, there are three major classes of shell abnormality:

1. Rough, sand paper-like shells point to a delayed oviposition. Environmental farm factors, for example too high a temperature or a cold draught, can cause retention of the egg in the oviduct while additional calcium deposition occurs. This can lead to brittle, pink coloured shells.

2. Misshapen eggs are usually the result of a disturbance of the deposition of calcium carbonate in the shell gland by (viral) disease or stress. Irregular ovulation in young flocks, as well as stress or disease in the hen, can influence shell quality and result in misshapen eggs, such as the flat sided example shown in the photo. Another type of misshapen eggs are so called 'body checks': eggs that have broken and repaired in the shell gland. Externally, this is visible by a thickened ring around the egg. Conditions in the farm-house, for example fighting between birds, cold draughts or high temperatures, can influence the external appearance of the shells in a batch of eggs.

3. White, pigment-less shells are often the result of viral infections, like infectious bronchitis (IB), egg drop syndrome or avian influenza. IB eggs are not only white, but also have abnormal shapes and albumen quality is often affected, with thick albumen becoming thin and watery.

Advice

- Score the general appearance of eggshells: good, medium, poor, from each batch of hatching eggs that arrives at the hatchery.
- Perform a detailed analysis of 450 eggs, if general appearance scoring is poor.
- Contact the breeder farm manager or supplier if 3% or more of eggs are classified as poor.
- Use this simple classification as a guide for discussions with suppliers about egg quality. ■

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Coordinating disinfection at breeder farm and hatchery 50

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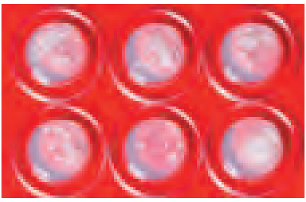
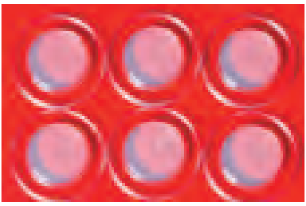
It is common practice for hatcheries to receive hatching eggs from more than one breeder farm or supplier. This guarantees a continuous flow of hatching eggs to the hatchery, to ensure that there is no interruption to the delivery of day old chicks. However, the practice of incubating eggs from different sources increases the risk of bacterial or fungal cross contamination between different batches of eggs.

With hatcheries growing larger, the number of suppliers or breeder farms delivering hatching eggs to one specific hatchery also rises, further increasing this risk of cross contamination.

For this reason, it is not unusual for hatching eggs to be disinfected at the breeder farm, or even during transport from the farm, before the eggs reach the hatchery.



Before disinfection.



After disinfection.

Optimised disinfection at the breeder farm preserves the quality of the eggs and the embryos.

Improper disinfection at the breeder farm is, however, likely to be one potential reason for embryonic mortality during the first 48 hours of incubation.

The main, critical issue relating to disinfection on the breeder farm is the temperature of the eggs at the moment of disinfection. The temperature of the egg on laying is 40°C, but this drops immediately when the egg leaves the hen's body. Some disinfectants, especially formalin, can diffuse into the egg during cooling, which may kill the embryo. To avoid early mortality, the eggs need to be cooled down to 20-25°C before disinfection. This may take between 4-6 hours, depending on conditions in the farm house.

The rate of cooling depends on temperature in the nest; the transporting belts and in the room where freshly laid eggs are sorted and prepared for disinfection and transport to the hatchery. The type of egg trays and/or boxes used to pack the eggs also has an influence on the rate of cooling.

Paper trays and boxes are good isolators and slow down the cooling rate of the eggs, whereas open plastic or setter trays facilitate cooling. 'Open' trays are recommended for disinfection at the farm, as they allow for good, all-over coverage of the surface of the eggs with disinfectant.

Hatchery managers are keen to standardise the protocols for egg disinfection at the hatchery. These protocols should be translated to and communicated with the breeder farm manager, with the aim of achieving a consistent, standardised approach to disinfection that will lead to improved results for both the farm and the hatchery.

Advice

- Collect eggs in a room not warmer than 20-25°C.
- Place the eggs on open (plastic) trays to facilitate uniform cooling to room temperature.
- Take care that eggs are cooled sufficiently before starting the disinfection procedure.
- Allocate a specific room for the disinfection of hatching eggs at the farm. This should include full control over temperature and (ideally) relative humidity.
- Avoid employing a daily disinfection schedule in the egg storage room at the farm, especially if eggs are transported to the hatchery just a few times per week. This avoids repeating disinfection.
- Standardise disinfection with regard to the concentration of the disinfectant, temperature, relative humidity and exposure time.
- Evaluate the effectiveness of disinfection at the breeder farm on a regular basis.
- Monitor early mortality, i.e. before the blood ring stage, on a routine basis.
- Check whether the agreed, standardised disinfection procedure is followed accurately at the farm, if early mortality is increasing. ■

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Loading incubators in balance for the best results

51

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By Gerd de Lange, Senior Poultry Specialist, Pas Reform Academy

Single stage setters and hatchers are designed to be used at full capacity. Their heating and cooling system and maximum air refreshment rate (= ventilation capacity) are calculated on fully loaded incubators.

Because there is no limitation from heating, cooling and the refreshment of air, it is logical to expect partially loaded setters and hatchers to function correctly and yield good hatchability and chick quality.

However, this is only true when the incubator is loaded with a good understanding of its working principles – and particularly of the purpose and effect of airflow.

Balancing the position of trays and trolleys in the partially loaded setter or hatcher is critical to optimising airflow during single stage incubation.

The fan in the setter and hatcher usually has a double function. In combination with the position of the in- and outlet- valve, it draws in fresh and expels used air.

But it should also drive a uniform airflow over all the eggs in the incubator, to ensure that a homogeneous micro-climate is created for the developing embryos.

Even when inlet and outlet valves are fully closed, the airflow generated by the fan re-circulates the air within the incubator.

After being acclimatised by the machines' heating or cooling device, air should move equally over all eggs, either heating the eggs to optimal embryo temperature, or removing the metabolic heat produced by the developing embryos.

To guarantee uniform temperature distribution and prevent areas of high carbon dioxide concentration, both of which may be detrimental to embryo development, 'dead zones' in the incubators are to be avoided.

Air will always travel the easiest route. In a fully loaded incubator, there is no easy route and the air is effectively forced over the eggs with equal difficulty, which optimises airflow.

When partially filled setters and hatchers are not loaded correctly according to the manufacturers' instructions, airflow over the eggs is distorted and becomes inconsistent due to the presence of larger, empty spaces inside the incubator.

The result of this imbalance is cold or hot spots and areas that lack fresh air. This principle also applies to partially loaded setter trays, for example after a 10-day candling procedure, and to hatcher baskets.

Advice

Contact your incubator manufacturer for their recommendations on partially filling their setters and hatchers. The following are general guidelines:

- Place full setter trolleys, or those that are at least nearly full, in front of the fan.
- Balance the positioning of the remaining, partially loaded setter trolleys by avoiding completely empty trolley positions, as this will create disturbances to airflow in neighbouring trolleys.
- Concentrate setter trays with eggs in partially filled trolleys in a 'block'. Avoid creating gaps, as these can become 'escape routes' for the air that will undermine the continuity of airflow over the egg mass.
- Avoid creating totally empty sections. These will be unstable in temperature due to the absence of egg mass, which can interfere with the climate experienced by eggs placed in neighbouring sections.
- Stack hatcher baskets evenly high and adhere to recommendations for minimum stack height.
- Use empty baskets in the hatcher to raise the position of the full baskets. This will optimise air flow through the full baskets.
- Avoid loading setter trays and hatcher baskets that are filled to less than 85% of their holding capacity, and place eggs in a partially filled setter tray according to the manufacturer's instructions.

Correctly interpreting 'dead in shell'

52

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A high percentage of 'clears' is usually regarded as a breeder farm or egg handling problem, whereas a high rate of late embryonic mortality is more likely to be seen as a hatchery failure.

While suboptimal incubation conditions may indeed be responsible, other non-hatchery factors should not be overlooked.

Determining, recording and monitoring levels of late embryonic mortality is good practice – and can be valuable to optimising hatchery results.

It is not uncommon for the term 'dead in shell', or 'DIS', to be used instead of 'late embryonic mortality'. Logically one would expect DIS to represent late embryonic mortality. But the question remains: on which day during incubation does mid-mortality stop and late mortality begin?

To avoid confusion around this definition, especially when sharing data with other hatcheries or consultants, it is recommended that DIS, as well as late mortality, are defined as follows: 'All embryos that died after the start of yolk sac retraction into the abdominal cavity, therefore all embryonic mortality after approximately day 17'.

According to this definition, DIS includes all embryos that died after transferring the eggs from setter to hatcher. It is worth noting that 'live pips' are not included in this definition, and raised numbers of these point either to pulling the chicks too early, or to too broad a hatch window.

Determining the true level of DIS can be problematic, as counting them accurately is not practically achievable. This is in contrast to 'clears', which are either counted electronically by the automatic candling equipment, or by simply counting, for example, the number of 30-egg flats with clears when using a simple candling table or hand candling lamp.

It is therefore not uncommon for DIS to be calculated based on the number of eggs set, minus clears removed during candling, minus hatched chicks.

While this method is easy and fast, it still may not accurately provide the actual levels of DIS or late embryonic mortality, as defined above.

Consider the following simplified example, derived from actual practice:

From a batch of 100 set hatching eggs, 15 clears are removed during candling. The remaining eggs are transferred to the hatcher, to produce 74 first class chicks and one culled chick on hatch day.

The hatchery manager calculates 100 - 15 - (74+1) = 10 DIS, or 10% of eggs set.

For DIS as defined above (ie. mortality after 17 days) this is far too high and could indicate considerable challenges in the hatchery.

However, performing a break-out on the 10 unhatched eggs still remaining in the hatcher basket after chick take-off finds: five clears (including one infertile egg and others with mortality up to the 'dark eye stage'); one mid-mortality and four late mortality embryos, in which retraction of the yolk has actually started.

So in reality, DIS is in fact much lower, at just 4%.

From this example, it can be concluded that DIS-figures should be interpreted with great care to avoid hasty or incorrect conclusions.

Advice

- Determine, record and monitor DIS levels on a regular basis in at least six baskets per batch.

- Recognise that a calculated DIS level (eggs set - clears - chicks) may not represent the actual percentage of late mortality.

- Perform a break-out of all unhatched eggs (after candling) from at least six baskets per batch to determine the actual percentage of late mortality.

- Pay attention to special observations while performing an egg breakout, such as the wetness of embryos, malpositions/malformations, rots and cracks and delayed chicks ('live pips'), as these provide relevant information for the optimisation of hatchery management and the fine tuning of incubation parameters.

- Take corrective actions if DIS levels exceed your hatchery specific flock-age dependent standards.

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Energy saving in setters

53

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By Marleen Boerjan, Director R&D, Pas Reform Academy

In modern hatcheries, electricity consumption by incubators can account for 35-50% of the hatchery's total electricity costs. Electric motors in both setters and hatchers are the greatest consumers of electricity.

To save cost, the hatchery manager can reduce the fan speed in the setter during periods of incubation when maximum air flow over the eggs is not required. However, in the hatchers, as maximum air flow is needed continuously to avoid overheating and suffocation of embryos and chicks, reducing hatcher fan speed is not advised.

A frequency controller, or 'Energy Saving Module' (ESM), can be installed in the setter to adjust fan speeds. The ESM allows the hatchery manager to design single stage incubation programs for savings of 24-30% in energy consumption by the electrical motors, without adversely affecting hatchability and uniformity.

In most setters the fan has two functions:

- Air intake.
- Recirculation of air over the eggs and between trolleys.

Air intake functionality is part of the ventilation system, controlled either by the air inlet valves (dampers) fixed set points, or by automatically controlling dampers based on RH and CO_2 set points. Maximum ventilation capacity (m^3/h) or air intake depends on fan speed and decreases at reduced fan speeds when energy saving programs are implemented.

The recirculation function of the fan directs airflow over the eggs, thereby controlling the uniformity of embryo temperatures. The shape and speed of the fan determine airspeed (m/s) and uniformity of air flow.

Both air intake and recirculation depend on the speed of the fan (revolutions/min). Consequently lowering fan speeds reduces air flow over the eggs and decreases maximum ventilation capacity.

Reducing fan speed to save energy therefore requires care, since embryo temperature (and growth) depend on temperature set points, air flow and ventilation rates (French, 1997).

In the first 3-5 days of incubation, sufficient heat must be transferred to the eggs to compensate for evaporative cooling. It is therefore not advised that fan speed is reduced during these initial days of incubation.

After day 13, maximum fan speeds support optimum development and prevent poor chick quality by overheating. From days 12-13 the embryos metabolise yolk lipids at high rates to support rapid growth. This increased yolk consumption requires sufficient oxygen and therefore increased ventilation.

Furthermore, increased lipid metabolism by the embryos initiates higher metabolic heat production. In this stage of development, cooled air flow should be optimised, to avoid overheating the embryos.

In conclusion, to support optimal development, saving energy by reducing fan speeds in setters is not recommended from day 13 to day 18.

Advice

- Implement energy saving when optimum hatch results are achieved with incubation programs based on maximum fan speed throughout.

- Test the impact of energy saving on hatch results on eggs from both high and low fertility flocks separately.

- If hatch results are below expectations, first reduce the number of incubation days using reduced fan speed from days 5-10, for example, instead of days 3-12. Secondly, adjust incubation temperature set points if hatch results remain below expectations.

- Maintain hatcher fans at maximum speed to avoid overheating and suffocation of hatching chicks.

- In general, ask the advice of equipment manufacturers regarding the use of an Energy Saving Module.

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Preventing cross-contamination in the hatchery 54

By Gerd de Lange, Senior Poultry Specialist, Pas Reform Academy

Due to its central position between breeder farms and poultry production houses for meat and eggs, optimised hatchery hygiene plays a crucial role in preventing the spread of pathogens in the poultry value chain.

Optimised hygiene in the hatchery is dependent on three key areas:

- Preventing pathogens from entering the hatchery, ie. maintaining biosecurity.

- Avoiding cross-contamination or the transfer of pathogens within the hatchery.

- Inhibiting further pathogenic development in the hatchery ie. cleaning and disinfection.

This article focuses on the prevention of cross-contamination from relatively 'dirty' rooms in the hatchery, such as the chick processing room, to what should be the cleanest room, the setter room.

To prevent cross-contamination, it is important to clearly demarcate the different hygienic zones in the hatchery: egg arrival area; setter room; candling/transfer room; hatcher room; chick handling and despatch room.

In a well designed hatchery, the practical implementation of the 'clean should never meet dirty' rule is easily achievable. For example, eggs being transferred to the hatcher do not cross the path of chicks just being pulled.

After being washed and disinfected, hatcher baskets do not pass through the chick room or any area where processing takes place, on their way to the transfer room.

And importantly, hatchery staff, including the technician responsible for maintenance, do not walk from the chick processing room to the setter room on a hatch day.

Differently coloured hatchery clothing and shoes, as well as tools like floor rubbers, greatly help to enforce hygiene-responsible behaviour by hatchery personnel.

Exploders, often caused by Pseudomonas spp, are an important source of cross-contamination between batches within the same setter.

To reduce this risk, batches with an increased incidence of exploders should be transferred to the hatcher last. Strictly applying the 'one batch per hatcher' rule, enabled by limiting the capacity of the hatchers, greatly prevents the risk of cross contamination, for example from older to younger batches.

In a well designed hatchery the number of hatchers per hatcher room is based on the daily production of chicks. This prevents recontamination after cleaning and disinfection, so minimising the risk of contaminating tomorrow's hatch.

Chick down, also a potential contaminant, is easily airborne. Its movement must therefore be controlled to prevent cross-contamination.

The setter room, to be maintained as the cleanest room in the hatchery, should be kept overpressure in relation to the hatcher rooms.

The accumulation of down in air ducts should be avoided, because this forms breeding grounds for moulds like Aspergillus spp. Air leaving the hatcher – and ideally also the setter – should be brought directly into exhaust plenums that can easily be cleaned and disinfected.

The use of air ducts should be restricted for clean, unused air only. In the hatcher, condensation on the cooling surface is normal and the majority of fluff will be caught by this moisture if the surface is large enough.

The integration of cooling pipes inside the wall panels creates a large surface area that significantly minimises the risk of cross contamination, while at the same time greatly reducing cleaning time and promoting excellent disinfection results.

Advice

- Organise regular hygiene awareness training for hatchery staff; people are often the weakest link in the 'hygienic chain'.
- Strictly apply the rule 'clean should never meet dirty' for eggs, people, air and items such as trolleys and trays.
- Maintain setter room in overpressure in relation to hatcher rooms to avoid the entrance of fluff.
- Transfer batches with an increased risk of exploders to the hatcher last.
- Plan daily chick production based on the number of hatchers per hatcher room.

Protocol to solve incubation problems

55

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By M. Boerjan, Director R&D, Pas Reform Academy

Even the best managed hatchery can experience difficulties sometimes, with incubation results that are below expectations or even disappointing. However, it is only possible to make the observation 'results are below expectation' if there is a history of hatchery data available for reference.

Such reference data is extracted from batch related information and collected daily on incubation results. This information may be collected either on paper recording forms or in computer spreadsheets. And in modern hatcheries, managers will use this information to extract reference data.

The methods used to extract hatchery specific reference data vary from hatchery to hatchery. Some hatchery managers calculate simple overall means per flock age, others use sophisticated statistical methods that take into account the dominant effects of egg storage length and flock ages on incubation results (Boerjan et al., 2011: IHP vol 27 (6):p13).

Poor incubation results are often first recognised when hatchery personnel find or recognise poor chick quality and many unhatched eggs left. In this situation, the risk of drawing incorrect conclusions, based on superficial observations and poor, incomplete data collected in a hurry, is high.

Confronted with poor results during chick collection, the team leader will immediately inform the hatchery manager, who is responsible for finding out what has happened on the same day that the challenge is identified. In this scenario, to avoid the risk of hastily drawing the wrong conclusions, it is advisable to follow a logical sequence of steps or protocol – as described below.

The first, most important task is to provide a detailed description of the problem with as much detail as possible. This is necessary both for internal communication and to assist in resolving the problem with external consultants or other parties, as required.

The first question to answer is whether the problem is an isolated incident related to a specific incubator or batch of eggs, or whether the problem has occurred previously or more frequently, but was not recognised by personnel.

With a quick review of the aforementioned data, the hatchery manager should be able to find this out fairly quickly. If the problem is not an isolated incident, a more detailed, specific analysis of the data will be required. This should go beyond a simple overall comparison of averages, at least the main effects of flock age and length of storage should be included.

Advice

- Ensure that hatchery data recording forms are always filled out completely. This is the fastest route to describing and solving the problem.
- Define the problem:
(1) Hatchability below expectation.
(2) Chick quality below expectation.
3) Hatchability AND chick quality below expectation.
- Define whether the problem occurs regularly, or is an isolated incident.
- Ignore the problem if poor hatchability appears incidentally, but keep an eye on the results of subsequent incubation cycles.

- Define whether the problem is
(1) flock; (2) egg handling or
(3) incubator related:
• If flock related: solve the problem in communication with the breeder farm manager.
• If egg handling related: evaluate and review egg handling protocols at the farm, during transport and at the hatchery (including disinfection.
• If incubator related: review the procedures for incubator maintenance and incubation programs.
- Take action according to findings and evaluate the effects of corrective measures taken on hatch results.

The true value of preventive hatchery maintenance

56

by Erik Meijer, Manager Parts & Maintenance Programmes, Pas Reform Hatchery Technologies

Modern hatcheries are capital intensive, production orientated businesses that depend on minimal downtime to realise optimised profitability.

A well organised preventive maintenance program is therefore a critical focus for these businesses which, by anticipating and preparing for potential machinery or equipment failures, are far more efficient, smooth running and ultimately better placed to realise maximum returns on investment.

Operational or equipment break-downs and malfunctions can cause severe disruption to the business, potentially with serious and costly implications for hatchability and chick quality.

Waiting until equipment breaks down is the opposite of a proactive, well organised preventive maintenance program. It is important to avoid equipment break-downs and malfunctions because:

- They almost always come unexpectedly and at inappropriate moments, such as half way through an incubation cycle, in the middle of the night or during a festive holiday.
- The hatchery's technical engineer may not be available when the break-down or malfunction occurs, or not know exactly how to repair or solve an urgent problem.
- Relevant spare-parts may not be in stock and it may take several days for urgently ordered spare parts to be received.
- During the period of equipment break-down, followed by time to make the required repair, costs are being incurred, for example because hatchery staff are idle for some hours until they can re-commence their normal work activities.
- Depending on the duration of the break-down or equipment malfunction, such an event will almost certainly have a negative effect on hatchery results.

A skilled and dedicated technical staff and the ready on-site availability of a full range of spare parts are key ingredients for a successful preventive maintenance program.

With these factors in place, the hatchery can expect to achieve relatively uninterrupted operation, not only of incubation equipment, but also of supporting and auxiliary functions, such as climate control systems, hatchery automation, stand-by generator, alarm and waste systems, trucks and the many other services and systems that together support the comprehensive modern hatchery in its day-to-day operations.

A well organised preventive maintenance program typically includes:

- Regular checks to ensure that all hatchery equipment is functioning correctly.
- Carrying out relevant services and maintenance to extend the lifetime of essential parts.
- Replacing parts before they reach the end of their technically recommended lifetime.

When problems are detected during regular checks, there is still ample time to plan for the replacement of relevant parts before they actually break down, which is fundamental to preventing disruption to the smooth running of the hatchery.

Accurately recording maintenance activities generates an essential maintenance history for the hatchery, which will be invaluable in the event of changes to personnel. By analysing maintenance data over a longer time period, the frequency of preventive maintenance as well as specific instructions for maintenance activities can be adjusted.

With such a systematic approach to preventive maintenance, hatchery equipment can be expected to deliver top performance, achieve a maximum lifetime of use and contribute to hatchery reliability and profitability.

Advice

- List all hatchery equipment that requires preventive maintenance.
- Define who is responsible for the preventive maintenance of each item of hatchery equipment.
- Schedule the frequency of regular service/maintenance checks for each item of hatchery equipment.
- Describe what should be done at which interval. Make a distinction between activities that should be carried out daily, weekly, before each incubation cycle and less frequently, for example every six months.
- Record all preventive maintenance activities, including any and all corrective actions performed and/or which parts are repaired or replaced.
- Review maintenance records on a regular basis, to fine-tune the optimal frequency of the hatchery's preventive maintenance program.