Egg Products Plant Operations

Objectives

After completing this module, participants will be able to do the following:

1. Identify the key steps and procedures in egg products plant operations and the inspector's role in each.
2. Understand the time and temperature requirements for cooling liquid egg products.
3. Understand minimum temperature and holding requirements for pasteurization.
4. Cite the steps for conducting final product inspection.
5. Identify the actions to take when egg products are off condition.

References

1. Ask FSIS Website: http://askfsis.custhelp.com/
    - Search by "Egg Products" category to access al the published Q&As addressing shell eggs and egg products issues

Introduction

According to section 7(a) of the EPIA (21 U.S.C. 1036), all egg products plants are required to produce an unadulterated product that must be pasteurized before it leaves the official plant and enters commerce. All egg products in commerce must be *Salmonella* negative. The egg products inspection regulations, 9 CFR part 590, establish not only the basic sanitation requirements that are the foundation for egg products inspection, but also list the specific requirements for operating parameters such as temperature requirements or sampling protocols.

When inspection program personnel (IPP) verify that egg products plants meet food safety requirements, they are to evaluate the food safety procedures and associated activities observed in the plant. The ***purpose*** is for IPP to verify that the plant meets the applicable food safety regulatory requirements (9 CFR part 590) to ensure products are not adulterated (§ 590.5-Adulterated).

When the inspector observes ***evidence of failure*** while performing food safety tasks, we are looking at deficiencies/noncompliances that increase the risk of producing unsafe product that can result in food borne illness/injury; for example,

failure to meet the pasteurization temperature requirements for liquid egg products according to the regulatory requirements contained in § 590.570.

Once we observe a failure, we need to identify the ***cause of that failure*** by looking at those deficiencies attributed to:

- ***Process*** such as preventive procedures not identified, programs that are not effective or not maintained/re-evaluated (not re-evaluated routinely, after failures, or upon changes)

- Poor ***execution*** of programs; for example, not performing activities necessary to ensure product/process control, not maintaining records to demonstrate implementation and effectiveness of programs, not taking appropriate follow-up actions to address deficiencies in the execution of programs, or not verifying that the programs are being implemented.

Therefore, the ***consequences*** of that failure can result in lack/loss of control, with the potential for a food safety risk occurring. A lack/loss of control can result in an unsafe product, which may impact further processing or distribution into commerce, and if adulterated product enters commerce, then the consequence can be catastrophic to public health (injury/death).

Since operations vary and plants may use different processes, it is not possible to cover every requirement in the time allowed for this course. In this module, we will cover key regulatory requirements for the different operations in breaking and liquid egg products production. The regulations in 9 CFR part 590 set out the requirements for the plant. To perform your duties effectively, you must have a good working knowledge of these regulations.

General Operating Procedures

This section outlines procedures that the plant must follow to comply with the regulations (§ 590.504).

- Operations must be conducted in a sanitary manner.

- Pasteurization, heat treatment, stabilization (desugarization), and other processes must be conducted as per the regulations in part 590.

- Processes and temperatures in all operations must prevent deterioration of the egg products. Egg products are highly perishable.

Specific Procedures:

- All loss and inedible eggs must be placed in a container labeled **“**inedible”and must be denatured in accordance with the regulations.. IPP are to verify that operations involving the handling of eggs, ingredients and egg products are strictly in accordance with clean and sanitary methods and are conducted as rapidly as practicable. IPP are to verify that eggs and egg products are inspected in each official plant processing egg products for commerce. IPP are to verify that any eggs and egg products not processed in accordance with the regulations in part 590 or part 591 or that are not otherwise fit for human food are removed and segregated.

- IPP are to verify that all loss and inedible eggs or inedible egg products are placed in a container clearly labeled “inedible” and containing a sufficient amount of denaturant, such as an FDA-approved color additive, suspended in the product. Eggs must be crushed and the substance dispersed through the product in amounts sufficient to give the product a distinctive appearance or odor. Inedible product may be held in containers clearly labeled “inedible” which do not contain a denaturant as long as such inedible product is properly packaged, labeled and segregated, and inventory controls are maintained. Such inedible product must be denatured or decharacterized before being shipped from a facility.

- IPP are to verify that undenatured egg products or inedible egg products that are not decharacterized are shipped from an official plant for industrial use or animal food, provided that they are properly packaged, labeled, and segregated, and inventory controls are maintained.

- IPP are to allow an official plant to move egg products that have been sampled and analyzed for *Salmonella*, or for any other reason, before receiving the test results, if they do not suspect noncompliance by the plant with any provisions of this part. The official plant must maintain control of the products represented by the sample pending the results.

- Operations like pasteurization, drying, or stabilization must be started as soon as possible after breaking to prevent deterioration of the product, preferably within 72 hours. (This does not apply to egg whites, which are to be stabilized.)

- When equipment and utensils become contaminated during production, they must be immediately removed from the production area and must not be used again until cleaned and sanitized.

- All substances and ingredients used in egg products must be clean and fit for human use.

- Containers must be clean before use. Only new containers and used containers that are clean and lined with a suitable liner are acceptable.

- Inspectors must conduct a finished product inspection.

- All blood and meat spots must be removed, in addition to shell fragments and foreign materials.

- Egg products are to be tested for *Salmonella* to ensure the adequacy of the pasteurization or heat treatment process.

- If product is positive for *Salmonella* and the plant does not want to condemn the product, it must be

    - Reprocessed,
    - Pasteurized, and
    - Retested for *Salmonella*

- Shipping unpasteurized or *Salmonella* positive product is allowed only when the product is to be pasteurized, repasteurized, or heat-treated in another official plant. All containers in which the product is shipped must be sealed and accompanied by a USDA certificate describing the state of the product.

Egg Products Processing Operations

Now we will turn our attention to specific operations in egg products processing and the regulatory requirements unique to each operation.

As per § 590.5, the term *processing* meaning manufacturing of egg products, including breaking eggs or filtering, mixing, blending, pasteurizing, stabilizing, cooling, freezing or drying, or packaging egg products at official plants. Remember, as per § 590.420 and § 590.504(b), continuous inspection is required during egg products processing.

While performing the inspection verification activities associated with the production of egg products and the plant's operation, IPP will be entering the inspection results in the appropriate task.

For additional details on documentation and enforcement, see the "Documentation and Enforcement" section.

Receiving

Shell Eggs

All shell eggs and egg products entering or located in the official plant are subject to the 9 CFR part 590 regulations (§ 590.20). As per 9 CFR 590.510(c), shell eggs, when presented for breaking, shall be of edible interior quality and the shell shall be sound and free of adhering dirt and foreign materials.

Shell eggs received for processing in an egg products plant are usually *Nest Run* or *Restricted Eggs.* Section § 590.5 defines these terms, as well as others.

- *Egg:* the shell egg of the domesticated chicken, turkey, duck, goose, or guinea.

- *Nest Run:* eggs which are packed as they come from the production facilities without having been washed, sized and/or candled for quality, with the exception that some checks, dirties, or other obvious undergrades may have been removed.

  Note: Nest Run eggs are not required to be labeled.

- *Eggs of Current Production:* eggs that move through the usual marketing channels from the time of laying and are not in excess of 60 days old.

As stated previously in the “Biology of Eggs” module, a *restricted egg* is defined as a check, dirty egg, incubator reject, inedible egg, leaker, or loss. The container for restricted eggs must be properly labeled – restricted eggs shall be identified as required by § 590.800. Remember, some of these eggs can be presented for breaking, such as checks, dirty eggs (dirties), and leakers, provided that the requirements of § 590.510(c) are met, such as:

- Dirties must be cleaned and free of adhering dirt and foreign material; therefore, industry may wash these according to regulation § 590.515(a)

- Checks and eggs with portion of the shell missing may be used when the shell is free of adhering dirt and foreign material and the shell membranes are not ruptured (§ 590.510(c)(1))

- Eggs with clean shells which are damaged in candling and/or transfer and have a portion of the shell and shell membranes missing may be used only when the yolk is unbroken and the content of the egg are not exuding over the outside shell (§ 590.510(c)(2)). These eggs must be properly segregated, put in clean leaker trays, and broken only by specially trained personnel.

- Eggs with meat, or blood spots may be used if the spots are removed in an acceptable manner (§ 590.510(c)(3)).

There is an askFSIS question addressing eggs ineligible for breaking (entitled “Eggs Ineligible for Breaking” – FSIS website): Are there any circumstances under which filthy and decomposed eggs would be eligible for breaking and then processing into egg products at an official plant?

> **No**, as per 9 CFR 590.510 and 590.504
> (c), filthy and decomposed eggs,including inedible and loss eggs, must be placed in a container clearly labeled "inedible" with a denaturant or decharacterant. They must be crushed and the denaturant or decharacterant dispersed through
> the inedible product such that it has a distinctive appearance or odor.
>
> Inedible eggs include black rots, yellow rots, white rots, mixed rots, green whites, eggs showing blood rings, eggs containing developed embryos at or beyond the blood ring state, moldy eggs, musty eggs, and sour eggs.
>
> Loss eggs include those that are smashed or broken so that their contents are leaking; are overheated, frozen, or contaminated; incubator rejects, or contains a bloody white, large meat spots, a large quantity of blood, or other foreign material. Loss eggs are adulterated and are therefore unfit for human food.

All other filthy and decomposed eggs are ineligible for breaking (§ 590.510(d)), including:

(1) Any egg with visible foreign matter other than removable blood and meat spots in the egg meat
(2) Any egg with a portion of the shell and shell membranes missing and with egg meat adhering to or in contact with the outside of the shell
(3) Any egg with dirt or foreign material adhering to the shell and with cracks in the shell and shell membranes
(4) Liquid egg recovered from shell egg containers and leaker trays
(5) Open leakers made in the washing operation (see below)
(6) Any egg which shows evidence that the contents are or have been exuding prior to transfer from the case

Also consider that § 590.510(e) does not allow for incubator rejects to be brought into the official plant.

In-plant inspectors observe the condition of the shell eggs presented for breaking and need to make sure that the plant does not reintroduce ineligible shell eggs for breaking, so they need to know when the plant is receiving the shell eggs.

- The inspector needs to verify that plant management maintains records that show all incoming supplies of shell eggs are in compliance with § 590.200.

- IPP need to be aware of shell eggs that have been diverted to the plant in accordance to FDA's prevention of *Salmonella* Enteritidis in shell eggs final rule (two askFSIS Q&A published– FSIS website). IPP are to verify that the plant has established controls to ensure that any egg product produced using this type of shell eggs are segregated, pasteurized, and tested to confirm that the finished product is *Salmonella* negative.

  Note: Shell eggs diverted to an official egg products plant under the FDA final rule are eggs that could pose a risk to public health.

- As discussed in the "Inspection Verification" module, Highly Pathogenic Avian Influenza (HPAI) buffer zone shell eggs for breaking must have the required documentation (refer to FSIS Notice 27-16)

  Note: there are several askFSIS Q&As that gives instructions on measures that must be follow to provide the appropriate documentation needed to accompany shipments/load of shell eggs destined for breaking, in addition to measures the plant must take to receive and process this type of shell eggs (published – FSIS website).

In cases where the plant has not provided the State permit form for the incoming shell eggs intended for breaking that originated from an APHIS control/buffer zone, IPP are to apply a U.S. Retain tag to hold the affected lot of shell eggs and ensure that the tagged shell eggs are segregated until a permit is provided or supplied; contact your immediate supervisor.

You are to schedule in PHIS a routine or directed Review Egg Plant Data task to your task calendar at a frequency determined by the type and source of incoming domestic shell eggs as per FSIS Notice 27-16. Document the results of your verification activities of the domestic lots by stating that regulation 9 CFR 590.200 was verified. If you scheduled an additional directed instance of the task, select the reason “Instructed by Supervisor” when scheduling the task.

Liquid Egg Products

Plants may also receive bulk liquid egg products (pasteurized or unpasteurized) under seal and accompanied by a certificate from another official egg products plant (§ 590.410(b)), and required documentation if the egg products were produced from shell eggs associated with HPAI (refer to several askFSIS Q&As published – FSIS website). In plants (origin plants) that intend to ship unpasteurized liquid egg product that was produced from shell eggs of an affected HPAI flock or control zone to another FSIS-inspected egg products plant (destination plant) for pasteurization, IPP at the origin plant are to verify shipment following the instruction in FSIS Notice 27-16, Part III, D.

In addition, 9 CFR 590.424 requires that all egg products be reinspected by an inspector at the time they are brought into the official plant. The products received must be properly identified and are to be inspected organoleptically by the inspector, including verifying the temperature of the liquid product in tankers.

Liquid egg products being shipped must meet specific regulatory temperature requirements at the origin plant. These temperature requirements are in 9 CFR 590.530(c) Table 1 – *Minimum Cooling and Temperature Requirements for Liquid Egg Products.* However, this regulation applies only to egg products at the origin plant at the time of shipping. They do not apply to egg products received at another official plant (refer to askFSIS Q&A entitled “Temperature Requirements for Receiving Liquid Egg Products” published– FSIS website).

When a plant receives product that exceeds the temperatures identified in *Table 1- Minimum Cooling and Temperature Requirements for Liquid Egg Products* or the receivers’ specifications, the plant has to decide if it will accept or reject the product.

- If the receiving plant rejects the product, the origin plant may receive the product back (under seal and certificate – apply new seals and issue a new certificate), or send it to inedible processing (need to meet the §

590.504(c) requirements). Regardless of the final destination, you will follow established procedures for verifying disposition of the affected lot.

- If the plant accepts the product, it should get priority processing so that the temperature is reduced as quickly as possible. The plant may do this by pumping the product through a chill press or by pasteurizing the product. How long it takes to reduce the temperature depends on the plant's product handling capabilities.

Because regulation § 590.530(c) does not apply to the receiving plant, do not write an NR simply because the plant received egg products that exceed this regulatory temperature requirement. The egg product inspector still has to conduct an organoleptic examination to ensure that the egg product is acceptable.

Shell Egg Cooler

Most egg products plants hold the eggs in a shell egg cooler prior to breaking. As part of your inspection duties, you will verify that the shell egg cooler is maintained in a sanitary manner (§ 590.500(j)).

A key element for the holding room is proper temperature control to slow the microbial deterioration of the eggs. According to FDA's Final Rule (2010) all eggs, including those intended for breaking, must be kept at an ambient temperature of 45ºF within 36 hours of being laid.

IPP do not specifically inspect shell eggs/cartons in the cooler, but musty odors or visible mold on containers are red flags to the inspector indicating that he/she is to make the appropriate determination before those shell eggs are washed (see below).

Transfer Room – § 590.508

In the transfer room, shell eggs are loaded or delivered to the shell egg washer.

In preparation for processing, shell eggs are placed on pallets and/or on filler flats and then onto a conveyor. They are then staged to start the candling, washing, sanitizing, and breaking process. Shell eggs are placed in the transfer room prior to being transferred onto the shell egg washer. Time in the transfer room serves two purposes:

- It allows the cold eggs to warm slightly after being in the shell egg cooler, a process called *tempering.* Tempering helps to prevent the eggs from expanding and cracking during washing and sanitizing. It is also important to prevent the eggs from sweating (§ 590.508(c)). Sweating occurs when

cooled eggs from storage are placed directly into the warm moist environment of the transfer/washing room.

- It increases the yield from each egg, since cold fresh eggs do not yield as much of the content as warmer eggs.

The conveyor belt moves the eggs to a vacuum loader. The loader uses suction cups to lift and transfer the shell eggs to the washer.

While the eggs are on the conveyor, IPP have another opportunity during their regularly scheduled tasks to observe the condition of the eggs and the condition of the equipment. If a strong odor is detected from either the shell eggs or the cartons, the plant must segregate and candle the eggs prior to breaking and have them examined by qualified plant personnel (§ 590.510(b)).

If slight mold is detected on packaging material or on an occasional sound shell egg, both the plant and the inspector need to further investigate before the eggs are washed. The product must be re-examined by both the plant and IPP to determine the source of the odor before the eggs are washed, since washing will remove the visible mold.

Note: Plant is not allowed to wash mold off eggs.

Because moldy eggs are inedible (§ 590.510(d)) and are not eligible for breaking, you need to take the following actions:

- Stop operations in the transfer room until the affected lot is removed.
- Verify that the plant washes and sanitizes all affected transfer room equipment prior to restarting operations.
- Place the affected shell egg lot under “U.S. Retention” until management informs you of product disposition (for example, the eggs are to be hand segregated or discarded to inedible).

If you have reason to believe that moldy eggs have already entered the breaking room, you also need to take the actions specified above for the affected breaking room operations, equipment, and product (§ 590.522(h), (i) and (j)).

Candling

Candling is performed, in general, in the transfer room. Candling is important in all breaking operations, especially when the breaking equipment does not present the shell with the contents of the broken egg – for example, on enclosed systems such as the Optibreaker.

Candling is not necessary for clean and sound shell eggs, but if the plant is handling restricted eggs (i.e., any check, dirty egg, inedible, leaker, or loss) then these type of eggs must be candled as per § 590.506(d) and § 590.510(b) using an approved candling device. In the candling process, the eggs are mechanically rotated several times over a bright light to examine the internal quality of the egg. This is a critical processing step, because it's the last opportunity to remove inedible eggs before they're broken.

Egg products plants may have more than one candling area (before and after the washer), depending on the segregation procedures, egg-shell quality and classifications, and conveyor speed.

Plant employees sort, classify, and segregate the eggs to ensure that only eggs eligible for breaking enter the breaking room (§ 590.510(c)). As part of the segregation process, employees will remove inedible eggs. To prevent interruption of the breaking operation, employees may replace any dirty, leaker, inedible, or loss eggs with sound shell eggs that have been cleaned.

The inspector is to:

- observe and verify that inedible/ineligible eggs are identified and removed before breaking
- perform organoleptic inspections and review records
- determine compliance and complete appropriate documentation in PHIS

Washing – § 590.515

The next step in the process is washing the shell eggs. The regulation covering egg cleaning operations is § 590.515. Egg products plant practice is to clean shell eggs before breaking since the egg contains bacteria on its surface. The regulations do not require shell eggs to be washed before breaking, but if eggs are dirty, they must be cleaned (§ 590.510(c)). It only takes one dirty egg to get through and be broken to stop the entire operation for cleaning/sanitizing and identifying all affected product.

Recall from the Sanitary Requirements module that the water supply utilized for egg processing and handling operations shall be ample, clean, and potable (§ 590.500(h)).

The washing operation must meet the following requirements:

1. The temperature of the wash water shall be maintained at 90ºF or higher, and shall be at least 20ºF warmer than the temperature of the eggs to be

washed. These temperatures shall be maintained throughout the cleaning cycle (§ 590.515(a)(2)). IPP are to perform a hands-on water temperature check – take the temperature on the water tank under the washer (not to exceed 120ºF)

Note: This prevents thermal cracks due to expansion of egg contents. Some eggs may show evidence of albumin along a crack because of thermal expansion caused by the washing operation. These eggs may be broken if the breaking is done immediately. Inspectors are to verify that the crack was due to thermal expansion and not due to improper handling.

2. An approved cleaning compound shall be used in the wash water (§ 590.515(a)(3)).

3. Wash water shall be changed approximately every four hours or more often if needed to maintain sanitary conditions, and at the end of each shift (§ 590.515(a)(4)). Excess foaming is to be corrected immediately. IPP verify that wash water is changed as needed; observe that there is no excess foaming in egg washer – overflow tank (plant can add an anti-foaming agent).

4. Replacement water shall be added continuously to the wash water in the washers to maintain a continuous overflow. Rinse water and chlorine sanitizing rinse may be used as part of the replacement water. Iodine sanitizing rinse may not be used as part of the replacement water (§ 590.515(a)(5)).

5. The washing operation shall be continuous and shall be completed as rapidly as possible. Eggs shall not be allowed to stand or soak in water. Immersion-type washers shall not be used (§ 590.515(a)(7).

Keep in mind that brushes used in the washing operations are strong enough that if a check is being washed then it will likely be a leaker by the end of the wash process. Therefore, it is essential that the brushes are maintained in a sanitary manner to prevent cross-contamination of the eggs (shell egg cuticle can be removed by washing)

Sanitizing and Drying – § 590.516

The sanitizing and drying of shell eggs is done just prior to entering the breaking room, i.e., this operation is not conducted in rooms in which edible egg products are being produced. The purpose of applying a sanitizer after washing the shell eggs is to kill any remaining bacteria by applying an approved sanitizer.

Sanitizing must be conducted to meet the regulatory requirements.

- Immediately prior to breaking, all shell eggs shall be spray rinsed with potable water containing an approved sanitizer of not less than 100 parts per million (ppm) nor more than 200 ppm of available chlorine or its equivalent. Alternative procedures may be approved by the Administrator in lieu of sanitizing shell eggs washed in the plant (§ 590.516(a)).

  Note: FDA defines what can be used as sanitizers, such as alkaline water, ozonated water, etc. If the plant wants to use alternative procedures, it has to be approved by FSIS and go through the approval process; the Agency will issue a No Objection Letter (NOL). If the plant is using an NOL, IPP are to review the NOL and verify that the plant is following the provisions outlined in the NOL.

- Shell eggs shall be sufficiently dry at the time of breaking to prevent contamination or adulteration of the liquid egg product from free moisture on the shell (§ 590.516(b)).

The plant will monitor the concentration at a frequency throughout the shift, including before the starting of operations. The inspectors are to:

- Verify that the sanitizer solution strength from the reservoir is within the required specifications.

- Review chlorine check (or water pH) records; inspectors can do the concentration check themselves (hands-on activity) or observe the plant employee performing the check, using a test kit – according to § 590.522(o), and recording the results.

- Verify that the plant is ensuring that the shell eggs are sufficiently dry prior to breaking (not dripping – economic adulteration with water).

Before the sanitizing step, there is a pick-off station where plant employees remove eggs that are considered dirties or leakers; dirties go to the dirt return system back to the washer to be rewashed. In general, plants place the leakers into the inedible bucket.

Breaking Room Operations – § 590.522

In the breaking room, shell eggs are broken and the contents are separated from the shell. After the egg is broken, the breaking machine can separate the yolk from the white.

The egg-breaking and separating machine is the heart of an egg products plant. Its main components are:

- *Cracker assembly:* the mechanism that receives, cracks, and opens the shell egg and retains the shell until it is ejected

- *Cracker knife:* the part of the cracker assembly that penetrates the shell and assists in retaining the open shell

- *Receiving cup assembly:* the mechanism that receives the shell egg content from the cracker assembly for inspection; it may also separate whites and yolks

Other components are:

- *Product trays:* trays that collect liquid egg and deliver it to the collection vats

- *Cup rinse:* a mechanism for rinsing the receiving cup assemblies

- *Processing air:* filtered air used in contact with the product for an organoleptic inspection. This airline is positioned, prior to the visible inspection, by the breaker operator; the air is blown across the cups to aid the operator in detecting an unacceptable egg, such as black rots, sour, mixed rots, etc.

- *Automatic yolk detection system:* the electronic eye is positioned on the albumin cup; if the scanner detects yolk in the albumen cup, an automatic rejection of the separation cup takes place. The cup continues to the whole egg tray and empties its contents into the whole egg line (this type of product is called incidentally or accidentally broken whole eggs).

Key breaking room regulatory requirements include:

1. Each shell egg shall be broken in a satisfactory and sanitary manner and inspected for wholesomeness by smelling the shell or the egg meat and by visual examination at the time of breaking (§ 590.522(f)).

2. If blood, meat spots, or shell fragments accidentally fall into cups or trays, they shall be removed (§ 590.522(g)).

3. Whenever an inedible egg is broken, the affected breaking equipment shall be cleaned and sanitized (§ 590.522(h)).

4. Breaking machines must be operated at a rate to maintain complete control and accurately inspect and segregate each egg to ensure the removal of all loss and inedible eggs (§ 590.522(aa)). When an inedible egg is encountered on mechanical egg breaking equipment, the inedible

egg and contaminated liquid shall be removed (§ 590.522(aa)(1). In addition, the machine should be cleaned and sanitized accordingly. The cleaning frequency needs to be adequate to minimize accumulation of egg meat on the machine surface (§ 590.522(aa)(3)).

Breaking operations are to be discontinued when foreign odors, which hinder the organoleptic inspection of egg products, are detected. If management fails to maintain control and to segregate shell eggs entering the breaking room, the inspector must take regulatory action by applying U.S. Reject/Retain tags to stop breaking room operations, no matter how many machines are involved. Every time an inedible egg is broken, the affected breaking equipment must be cleaned and sanitized, and the product on the affected recovery trays must be diverted/product discarded as inedible. When the breaker operator encounters a loss egg the required actions to be taken are:

— stop the breaker machine
— remove affected pieces of equipment
— carefully empty contents into inedible container
— the trays, cracker heads and separating cups must be replaced with clean and sanitized equipment; if a black rot is broken, then all of the breaking equipment must be cleaned and sanitized

Operations may not resume until plant management has taken appropriate corrective measures.

IPP responsibilities include:

- checking for positive air flow – can be done by using a cigarette lighter when entering the breaking room, if the flame tilts in the direction of the breaking room then is evidence of positive air flow

- making periodic checks to determine the accuracy of the segregation of shell eggs and egg liquid

- checking the product by performing visual observations and using the inspector’s sense of smell on eggs at the individual breaking machines; do an overall organoleptic inspection on the ambient air

- performing frequent organoleptic reexaminations and pour tests after breaking and before entering accumulation vats

After breaking, the liquid egg product will go through the process of filtering to remove shell particles and other foreign material; this is accomplished where the liquid egg product:

- flows into collection vats or balance tanks, by gravity, and a perforated plate contained within the vat makes the first eggshell filtration

- then product is pumped through the second filtering step where strainers (for example, self-cleaning filters) remove finer shell particles and the chalazae/vitelline membrane, creating a homogeneous liquid

After the egg product goes through all the filtration steps, IPP will perform the pour test by pouring liquid into a clean and sanitized bucket and allow the product to settle or rest for 2 – 3 minutes. At the end of that period, carefully, pour the contents of the bucket, by rotating the bucket, back into the balance tank; observe if there is any foreign residue or sediment in the empty bucket.

Liquid Egg Cooling – § 590.530

Thereafter, the liquid egg product is pumped to a cooling system (through heat exchangers). A storage handling systems stores the liquid egg products at cold temperatures before any further processing takes place.

Storage in the holding vessels or silos has to comply with the requirements of § 590.530(c) – minimum cooling and temperature requirements for liquid egg products.

- Liquid eggs will be considered satisfactorily cooled only when the entire mass of the liquid reaches the required temperature (§ 590.530(b)).

- Cooling and temperature requirements are specified in §590.530 Table I (see following page). For unpasteurized products, the required temperature must be met within 2 hours from the time of breaking.

The temperature of previously cooled product may rise because of further processing operations such as blending, homogenizing, or reconstituting dried products. The temperature must be reduced to meet the requirements.

As per § 590.530(a), surface coolers and liquid holding vats containing product shall be kept covered while in use.

Table of Minimum Cooling and Temperature Requirements – Liquid Egg Products
Table 1 of § 590.530

[Unpasteurized product temperature within 2 hours from time of breaking]

Product	Liquid (other than salt product) to be held 8 hours or less	Liquid (other than salt product) to be held in excess of 8 hours	Liquid salt product	Temperature within 2 hours after pasteurization	Temperature within 3 hours after stabilization
Whites (not to be stabilized)	55 °F. or lower	45 °F. or lower		45 °F. or lower	
Whites (to be stabilized)	70 °F. or lower	55 °F. or lower		55 °F. or lower	([1])
All other product (except product with 10 percent or more salt added)	45 °F. or lower	40 °F. or lower		If to be held 8 hours or less 45 °F. or lower. If to be held in excess of 8 hours, 40 °F. or lower	If to be held 8 hours or less, 45 °F. or lower. If to be held in excess of 8 hours, 40 °F. or lower.
Liquid egg product with 10 percent or more salt added			If to be held 30 hours or less, 65 °F. or lower. If to be held in excess of 30 hours, 45 °F. or lower	65 °F. or lower[2]	

9 CFR 590.530 - Table 1

[1]Stabilized liquid whites shall be dried as soon as possible after removal of glucose. The storage of stabilized liquid whites shall be limited to that necessary to provide a continuous operation.
[2]The cooling process shall be continued to assure that any salt product to be held in excess of 24 hours is cooled and maintained at 45 °F or lower.

(Source: http://ecfr.gpoaccess.gov/)

Freezing Operations – § 590.536

Freezing operations are to be in accordance with § 590.536 which states:

- For unpasteurized egg products – should be solidly frozen or reduced to a temperature of 10ºF or lower within 60 hours from time of breaking.

- For pasteurized egg products – should be solidly frozen or reduced to a temperature of 10ºF or lower within 60 hours from time of pasteurization. In other words, after pasteurization the product can be packed immediately or various hours later, therefore, the clock for the 60 hours count starts after completion of the pasteurization run for the particular product.

In addition, the plant can submit a request to FSIS-RIMS for a regulatory waiver, for a freezing time extension of >60 hours, which must include data demonstrating that the product is still safe and wholesome. If the Agency grants a waiver for a time extension, the plant must follow the waiver's specifications. If the plant is using a regulatory waiver, IPP are to review the waiver and verify that the plant is following the provisions outlined in the waiver.

Off-premise freezing is permitted only when prior approval is obtained in writing from the Administrator (§ 590.534(a)). An egg products plant requesting the use of off-premise freezing should submit its request to the front-line supervisor and complete FSIS Form 5200-10, *Application for Off-Premise Freezing of Egg Products.*

Defrosting Operations – § 590.539

Defrosting is performed in a controlled manner (§ 590.539(c) and (d)) to change the product from the solid state to the liquid state in the processing of egg products. Frozen egg products should be defrosted in a sanitary manner according to the regulations.

Further Processing

In the next sections of our discussion, we will be giving an overview of two processes widely used in the egg products industry: pasteurization and dehydration or drying of egg products. Notice that there are different formulations used, depending on the final product produced, which will have an impact on each of the processing steps.

We will start with the pasteurization of liquid egg products.

Pasteurization Operations

Pasteurization of liquid egg – § 590.570

Pasteurization is the main lethality step for destroying *Salmonella* in egg products. The principle behind pasteurization is that every particle of the product is rapidly heated to a required temperature and held at that temperature for a required minimum length of time to destroy the *Salmonella* organism.

The main method of pasteurizing liquid egg products is the High Temperature Short Time (HT-ST) method. The HT-ST pasteurization units may differ in configuration, but there are several key pieces to this equipment that IPP need to be familiar with the function and operation procedures for the complete pasteurization cycle.

HT-ST pasteurizers are available with plate and/or tubular heat exchangers (see Figure 1, page 17). The key factors are:

- controlling the flow rate and maintaining the temperature to retain the unique properties of the final egg product while ensuring efficient pasteurization

- depending of the viscosity of the egg product, the pasteurizer is configured with a specific pump and heat exchanger; the viscosity of the product depends on the type of egg liquid, temperature, dry matter, and content of salt and/or sugar

Appendix I – Figure 2 in the Plant Familiarization section shows the flow diagram for pasteurized liquid egg products, which covers the processing steps from the receiving of shell eggs/liquid egg products through the cooler/freezer storage, and shipping. We will be using this flow diagram for our discussion.

> **Note:** In the pasteurization process for egg whites, Hydrogen Peroxide may be introduced as an antimicrobial; the EPIH also describes other methods for albumen pasteurization (Ref: Egg Products Inspector Handbook (EPIH), Section 5 pages 34-37).

Figure 1 – Pasteurizer with tubular heat exchanger and plate heat exchanger

In practical terms, the HT-ST is a continuous process consisting of:

1. rapidly heating every particle of liquid eggs (whole eggs, whites, plain yolks, and mixtures) to a specific temperature range (125˚ - 150˚ F or higher)
2. holding the product at a definite temperature for the time required by the specific product
3. rapidly cooling the product

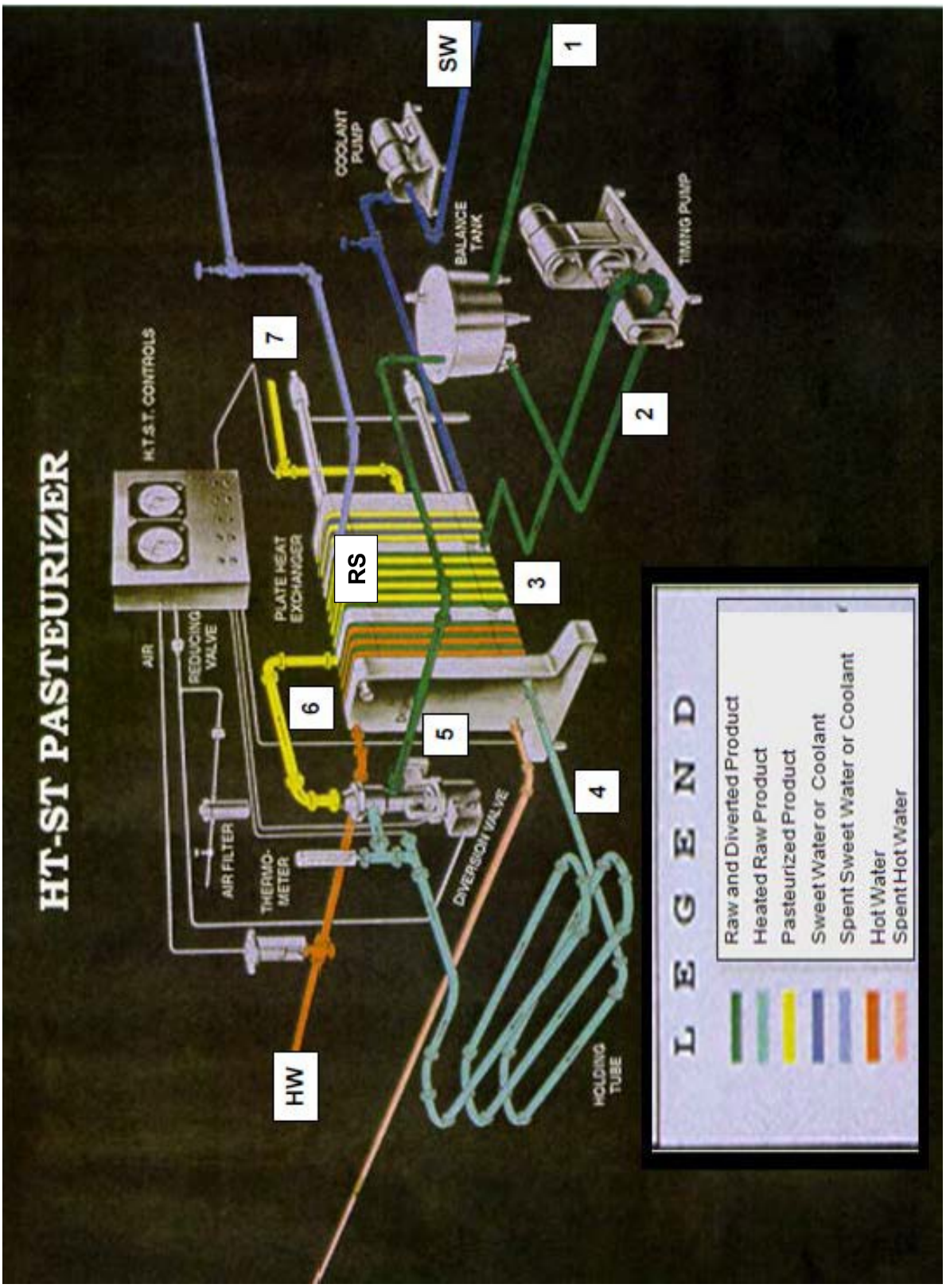


Figure 2 – Pasteurizer Equipment

Overall features of the pasteurizer are the feed pump, plate heat exchanger, holding section, flow diversion valve, and recording section. To be able to understand the pasteurizer, our discussion will focus on:

- the flow diagram of the pasteurization process
- plate/tube heat exchangers
- different segments of the pasteurizer including instrumentation

Let's take a look at the pasteurization process (refer to Figure 2 on page 20 for a schematic equipment layout – numbers in the figure represents the product flow once the raw egg product enters the pasteurizer as well as during the pasteurization process – see below for the explanation of the process).

The HT-ST pasteurizer is a continuous flow process. Before raw product is pasteurized the HT-ST cycle is started by running water into the system, as well as coolant and hot water. During the pasteurization process:

1. The raw product enters the system through the pipes and travels to the balance tank.

2. From the balance tank, it flows to and through the timing pump to a series of plates in the heat exchanger. The plate heat exchanger consists of the regeneration section (RS): heating, holding, and cooling section. The principle is to reduce energy cost by using part of the heat coming from the pasteurized product to pre-heat the incoming raw product. Vice versa, the pasteurized product is pre-cooled before it flows to the chilling section.

3. In the heat exchanger, the raw product is heated by both the pasteurized product and the heating medium until it reaches the desired temperature.

4. The heated product exits the heat exchanger and flows through the holding tube at the required temperature for a specific amount of time to the diversion valve (automatic safety system).

5. As the product runs through the flow diversion valve, if the product has not met the time/temperature requirement it is diverted back to the balance tank and the process is repeated.

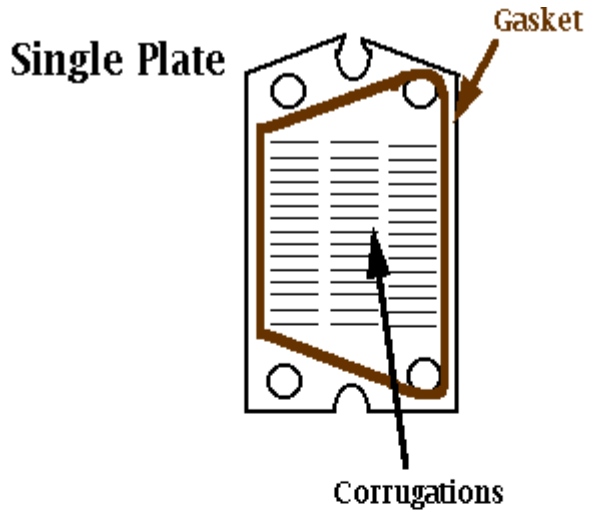
6. If the product has met the time/temperature requirement, it is now pasteurized and flows back through the heat exchanger where it is cooled by both the raw product entering the system and the coolant.

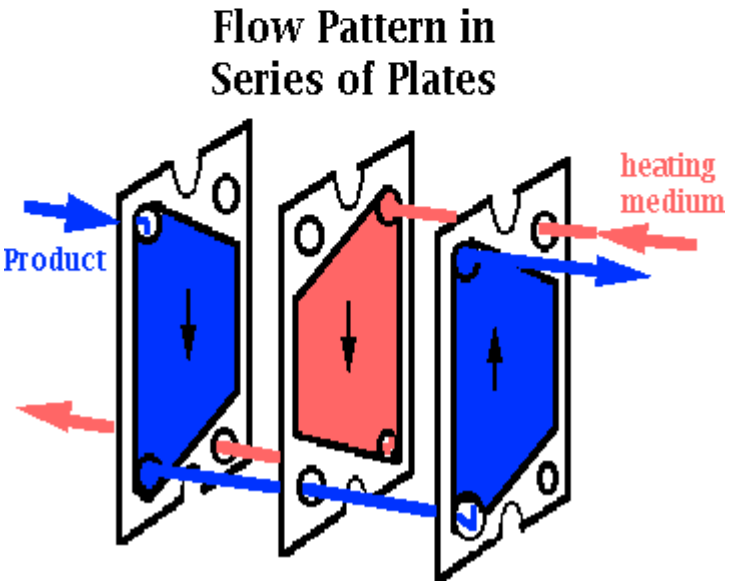
7. After it is cooled, it exits the system and flows to a holding silo.

Other features of the pasteurizer are the heating medium line (HW) and the coolant line (SW).

As mentioned above, the heat exchanger is one of the main parts of the pasteurizer. Following are examples of a simple schematic diagram of an HT-ST pasteurizer plate heat exchanger, along with a plate/gasket construction and concentric tube heat exchanger.

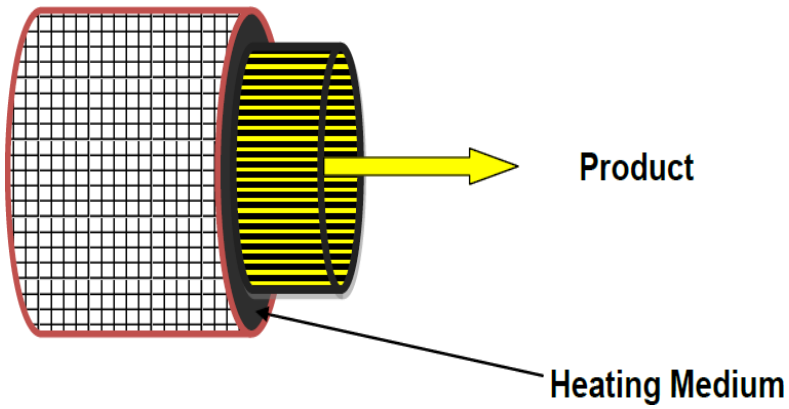
Schematic Diagrams of a Plate Heat Exchanger



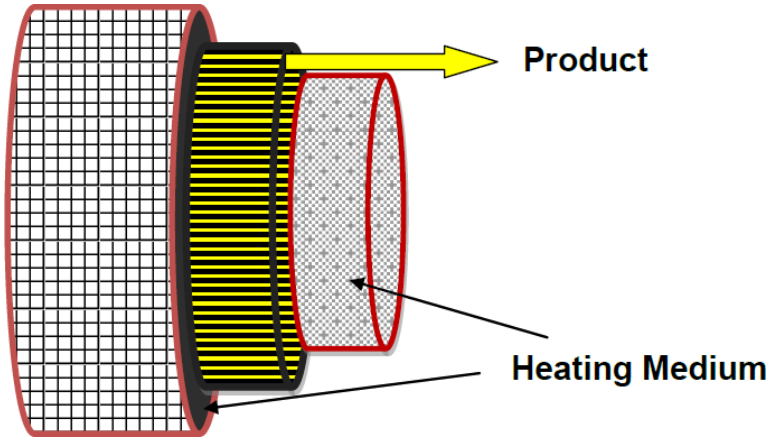


The heating medium represents the hot pasteurized liquid egg product from the holding tube while the product represents the raw liquid egg product coming into the pasteurizer.

Schematic Diagrams of Concentric Tube Heat Exchangers



Double Tube Heat Exchanger



Triple Tube Heat Exchanger

Concentric tube heat exchangers create a temperature driving force by passing fluid streams of different temperatures parallel to each other, separated by a physical boundary in the form of a pipe. This induces forced convection, transferring heat to/from the product.

Other pieces of equipment, which are part of the pasteurization unit:

- Indicating Thermometer – the purpose of the indicating thermometer is to accurately measure the temperature of the product. It is located at the end of the holding tube and as close as practical to the recording thermometer sensor.

- Flow diversion valve device with recorder-controller – this is necessary to provide automatic control of the pasteurizing operation and to give maximum assurance that no product escapes exposure to the temperature and holding period required for the destruction of *Salmonella* and reduction of spoilage microorganisms. The flow diversion valve operates to divert any under heated egg liquid back into the raw egg supply tank for repasteurization before it can mix with already pasteurized product held in storage tanks. Daily inspection, testing, and recording of the flow diversion point on this controller are essential to maintain proper operation and to ensure that under-pasteurized product does not contaminate properly pasteurized product. Digital and recording thermometers should be in a proximity to the diversion valve (within 36 inches); check the temperature readings.

- Recording charts are required to indicate that the proper time/temperature requirements have been met. Be sure to verify that the recording paper is correct for the chart used.

- Holding tube – the purpose of the holding tube is to provide the required holding of every particle (as a function of time) of product at the required pasteurizing temperature. Holding tubes have several requirements that the inspector needs to verify (Ref: Egg Products Inspector Handbook (EPIH), Section 5 pages 24-27).

    1. The length of the tubes must be known to ensure that the required holding time is achieved.

    2. The holding tubes must be measured to ensure proper length and must be taken from the middle of the tube to ensure accuracy.

    3. The slope of the holding tubes is also a critical factor. The regulatory requirement is that the tube must have a continuously upward slope in the direction of the flow of not less than a quarter of an inch of incline for every inch of tubing. This must also be verified to ensure proper flow in calculating the holding time.

    4. The tubes also have requirements in that they may be wrapped, but no external heat may be applied.

Flow Rate and Holding Time

Holding time should be checked for each product at a frequency to ensure continuous compliance. This may require daily checks for each product. IPP are to verify the flow rate and holding time for each product.

The holding time must be calculated and exactly followed to destroy the *Salmonella* pathogen. The minimum values are set out in Table I of § 590.570 of the regulations (see table on next page).

> **Note:** Studies have shown that meeting any of the regulatory requirements for pasteurization found in Table 1 also inactivates Highly Pathogenic Avian Influenza (HPAI).

Pasteurization Requirements[1]
Table 1 of §590.570

Liquid egg product	Minimum temperature requirements (°*F*)	Minimum holding time requirements (*Minutes*)
Albumen (without use of chemicals)	134	3.5
	132	6.2
Whole egg	140	3.5
Whole egg blends (less than 2 percent added non-egg ingredients)	142	3.5
	140	6.2
Fortified whole egg and blends (24–38 percent egg solids, 2–12 percent added non-egg ingredients)	144	3.5
	142	6.2
Salt whole egg (with 2 percent or more salt added)	146	3.5
	144	6.2
Sugar whole egg (2–12 percent sugar added)	142	3.5
	140	6.2
Plain yolk	142	3.5
	140	6.2
Sugar yolk (2 percent or more sugar added)	146	3.5
	144	6.2
Salt yolk (2–12 percent salt added)	146	3.5
	144	6.2

9 CFR 590.570 - Table 1

[1]Pasteurization of egg products not listed in this table shall be in accordance with paragraph (c) of this section.
(c) Other methods of pasteurization may be approved by the Administrator when such treatments give equivalent effects to those specified in paragraph (b) of this section for those products or other products and results in a *Salmonella*-negative product.

Source: http://ecfr.gpoaccess.gov/

If the plant wishes to use a time-temperature combination that is not listed in Table 1, it must first get approval from the Administrator to use that process. Plants can apply for a regulatory waiver through FSIS/RIMS to request authorization for other methods of pasteurization as per § 590.570(c). If the plant is using a regulatory waiver, IPP are to review the waiver and verify that the plant is following the provisions outlined in the waiver.

The times and temperatures in Table 1 were determined based on thermal death studies. The USDA pasteurization process recommends a minimum of a 5 to 7 log-reduction of *Salmonella* spp. based on the egg product composition, residence time, and temperature in a flowing system. The pasteurization process is designed for the worst case scenario.

> **Note:** The pasteurization time/temperature requirements in 9 CFR § 590.570 are adequate to inactivate HPAI (refer to askFSIS Q&A published – FSIS website; Avian Pathology (October 2004) 33(5), 512 – 518; Journal of Food Protection (2009), Vol. 9, pages 1812-2016).

As stated previously, the holding time should be checked for each product at a frequency to ensure compliance with the regulations. Initially, when the egg product is pumped into the pasteurizer there is a waiting time (10-15 min at start of cycle – depending on the product formulation) where the product circulates through the pasteurizer to flush the water out and the product solid % to increase according to the formulation and product identity. Thereafter, determine the flow rate (do the bucket test) and verify against the equipment flow determination (if applicable) at the beginning of the cycle. Be aware that when pasteurizers are being run for longer time, it will impact the flow rate due to the heat exchanger getting plugged with product residue with time – cooking inside the plates.

Following is the thought process on how to determine the holding time (Ref: EPIH Section 5, pages 24-27; Job Aid #1). The holding time gives you how many minutes the product is being held in the holding tubes.

- The first step is to calculate the flow rate (volume per unit time). Usually, the inspector collects a given amount of liquid egg product during the pasteurization operation for a measured amount of time in seconds (convert the time in seconds to one minute). The flow rate is calculated by determining the net weight of the liquid collected and converting it to pounds per minute:

  Flow Rate = weight of liquid (lbs.) X time (per minute)

  Note: Flow rate is defined as a quantity of liquid moving through a pipe within a given time or standard period (usually a minute or hour).

Example 1: It required 30 seconds to collect 40 pounds of pasteurized whole eggs. Divide 60 seconds per min by 30 seconds = 2 per min. Multiply 40 pounds by 2 per minutes = 80 pounds of liquid per minute.

- Once the flow rate is calculated, and having the information of the holding tube capacity of the pasteurizer unit for a specific liquid egg product, the inspector is able to calculate the holding time.

  Holding Time (min) = holding tube capacity (lbs.) ÷ flow rate (lbs./min)

  Example 2: The product that has been pasteurized is Plain Whole Eggs. The capacity of the holding tubes has been calculated at 2790 lbs. for this product. The inspector determined that the product flow rate is 640 lbs./min. To determine the Holding Time divide 2790 lbs. by 640 lbs./min, which results in 4.35 min. Determine regulatory compliance with § 590.570 & record this value along with other required information if you find regulatory noncompliance using the appropriate food safety task.

Note: The plant must have records of the pasteurizers holding tube capacities, including the measurements of the length of all tubes and determination of the number of elbows and diameter of pipe for the each specific pasteurizer. The inspector is to maintain a record of the length and diameter of holding tubes in the government files; inspectors need to understand how to determine the holding tube capacity (EPIH – Section 5, Part V, subsection A.6; pages 24-27).

The inspector's responsibilities are to verify, among others (Ref: EPIH Section 5, pages 16-34):

- Before the start of pasteurization, the cleanliness and condition of each piece of the pasteurizer (pumps, heat exchanger plates, holding tubes, flow-diversion valve, etc.)

- That recorder charts contain all the correct information and are working properly

- Temperature of indicating thermometer, recorder controller thermometer and flow-diversion valve setting; verify the settings and parameters, for example:
  - Recorder controller – 146ºF
  - Indicating thermometer – 146ºF
  - Flow-diversion valve setting - 142ºF

  The indicating thermometer and digital thermometer temperature readings are between 0.5ºF of each other.

- The holding time determined for each product, for example

  - Flow rate/min – 640 lbs.
  - Holding time – 4.36 min

- At the end of the pasteurizer cycle – by completing a meter (flow rate) check:
  - Recorder and indicator thermometer temperature check
  - Recording chart is working properly
  - Pasteurization temperature for the product has been met

- Regulatory compliance with § 590.570; record the required information if you find regulatory noncompliance using the appropriate Egg Products Food Safety task.

After pasteurization, liquid product may be handled as follows:

- Packed in containers such as plastic buckets, bag-in-boxes, packages, milk containers, and so on to be marketed (can be as little as 4 oz. to 45,000 lbs. in tankers); packing operations must be conducted to minimize post-pasteurization contamination w/ pathogens or spoilage microorganism. Packaging system is designed to provide protection from post-process contamination.

- Further processed (add ingredients, freeze, or dry)

- Shipped in tankers to another egg products plant or distributor; before shipping, liquid egg products must be maintained below 40ºF (§ 590.530(c)); may be transported directly from the egg processing plant to the egg product user (no seals necessary unless required by the customer) or to other officially inspected plants for further processing (under seals & certificate)

Next, let’s discuss the drying operation.

Drying Operations

Dried or dehydrated egg products are also known as egg solids. Egg drying is one of the most common processes. Drying is to be accomplished in a clean and sanitary manner and the drier room maintained in a clean and sanitary condition (§ 590.542 – 549). The sanitation and the environment around the outside of the air intake, exhaust, and in the room affect the sanitary operation of the drier.

Industry has developed a variety of dried egg products, including dried egg white, dried plain whole egg and yolk, and specialty dried egg products.

Egg products fall under two basic categories when considering their drying characteristics:

- egg white products (i.e., whites)
- whole egg and yolk products (i.e., yellows)

Before the liquid egg products go through the drying process, industry uses processing techniques to achieve the desired finished product. These techniques alter the composition of egg components by changing the lipid or sugar composition, concentrating solids, or separating egg components (e.g., lysozyme and avidin).

The following processing techniques are used in drying:

1. Some egg products plants concentrate liquid egg whites prior to drying by removing excess water. Concentration of the liquid egg product before drying will improve the thermal efficiency and increase the capacity of the dryer. This is done in one of two ways:

    - *Reverse osmosis*: (the most common) an applied pressure is used to overcome osmotic pressure. As a result, the solute (albumen) is retained in the pressurized side of the membrane and the pure solvent (water) is allowed to pass to the other side

    - *Ultra filtration with special membranes*: is a variety of membrane filtration (depend on the shape and material of the membrane) in which forces like pressure or concentration gradients lead to a separation through a semipermeable membrane; suspended solids and solutes of high molecular weight (proteins such as albumen) are retained in the so-called retentate, while water and low molecular weight solutes pass through the membrane in the permeate.

2. To prevent discoloration of dried egg products (browning during the drying step), some egg products plants remove glucose from the liquid prior to drying. This technique is known as desugarization or stabilization. Stabilization is done in a fermentation process where the sugar is removed by one of the following processes:

    — adding a starter bacterial culture (applicable to egg whites)
    — adding a pure yeast culture (applicable to all egg products)
    — adding an enzyme (applicable to all egg products)

    The pH is monitored during the fermentation process. Once the targeted pH is reached, the product is cooled and stored in holding tanks until the drying step.

Note: FSIS inspection coverage is not required during the entire stabilization/desugaring time provided that the plant is not conducting any other processing activity that requires an inspector to be on duty (refer to askFSIS Q&A entitled “Coverage of Egg Products Plants-Stabilization/Desugaring” – FSIS website)

3. Industry utilizes desirable proteins commercially, like lysozyme, as food preservatives and/or for pharmaceutical purposes. The technology to separate high purity proteins is known as ion-exchange chromatography, where an ion exchange resin is used to isolate the desired protein (i.e., lysozyme and avidin) from egg white liquid products while still maintaining the functional properties of the product. Egg products where this technology is used must meet the labeling regulatory requirements.

Industry uses chemical additives to improve and keep the functional properties (whipping, coagulation, emulsification, flavor, nutrition, and color) of the final dried egg products. Examples of chemical additives include carbohydrates, whipping aids, emulsifiers, and anti-caking agents (colloidal silicon dioxide).

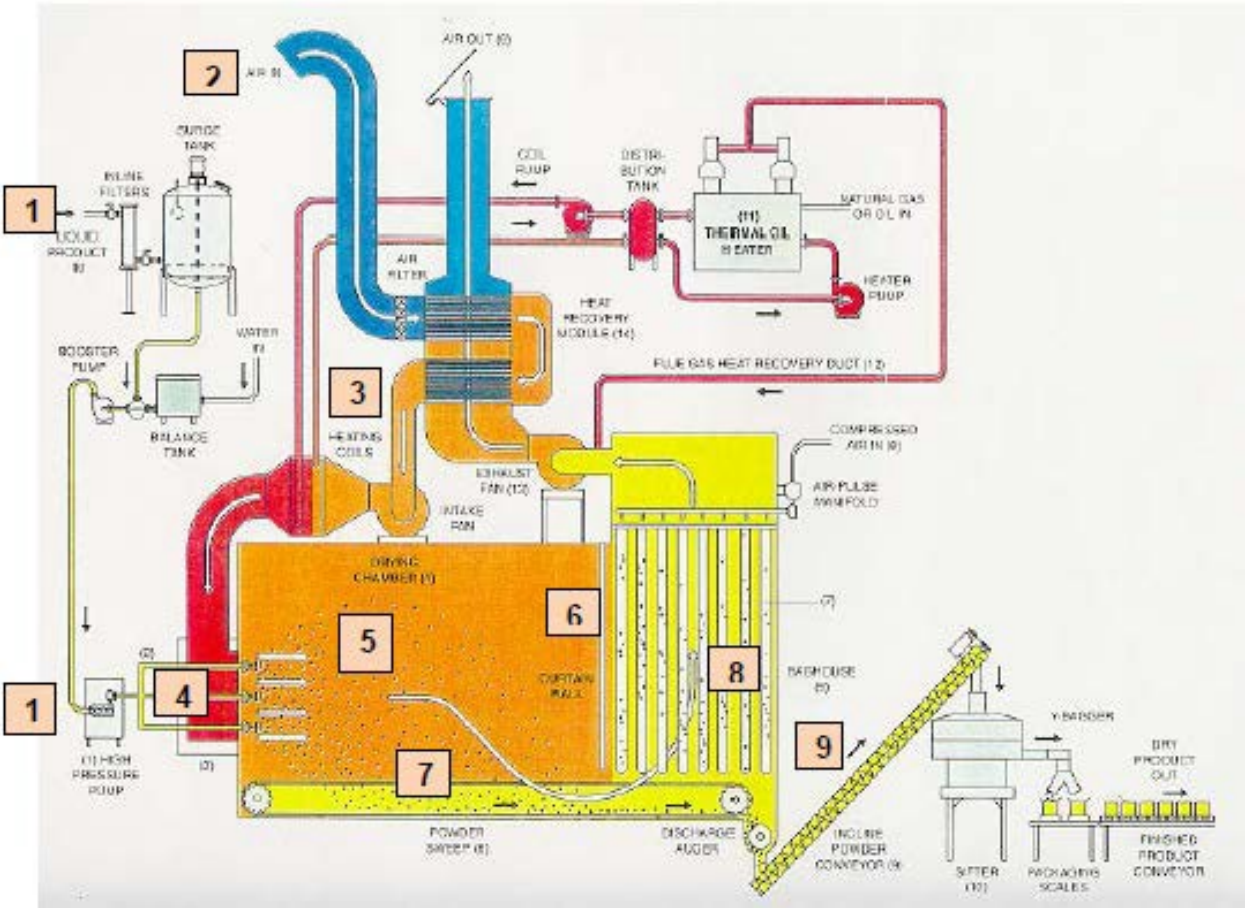
Drying Methods

The most common egg products drying methods used by industry are spray drying and pan drying (for whites only). Below is a description of these methods.

Spray drying

One method for producing dried egg products is *spray drying* – this method consists of spraying the egg liquid through a number of nozzles into a stream of hot air in a drying chamber (refer to Figure 3 below). Examples include the tower type, cyclone type, and box type. Yellow products are pasteurized prior to spray drying. Whites are pasteurized by heat treatment after spray drying.

Figure 3 – Drying equipment (box type)



Following is the explanation for the drying process of egg products (refer to the numbers in the diagram).

Before the liquid egg product enters the drying chamber (primary collection compartment):

1. First, the product is moved from the storage tank (silo) into the dryer by a high pressure pump or homogenizer.

2. Air for the dryer is drawn from the outside through a filter house where the filters remove dust and other contaminants.

3. A large fan draws the air toward the drying chamber and the air is heated between 250 – 450^0 F before entering the dryer.

At the Primary collection compartment:

4. At the left you have three openings where the hot air and liquid product meet. Each opening has four spray nozzles.

5. When the fine mist of sprayed egg product hits the stream of hot air, it causes the water to evaporate in less than a second and the solids become powder.

6. The powder is blown against the baffle plates and falls on the floor of the dryer.

7. The powder is continuously pulled toward a screw conveyor opening by a drag blade located on the floor.

At the Secondary collection compartment located behind the baffle plates:

8. This chamber

    - contains many cylindrical wire cages descending from the ceiling, each with a cloth filter or bag around it to trap dried egg product when the exhaust air is exiting through the secondary chamber

    - inside each cage is a horn through which pressured air is periodically blown to shake the bags causing the powder to fall on the compartment floor

    - the powder on the floor is then removed by the drag

Once the egg product is dried and in powdered form, it is then transferred to the packaging system:

9. The dried product (1^0 and 2^0 powder combined)

    - Is continuously discharged from the drying chamber and moved by a screw conveyor to the package room where it is packed in its final form.

    - The auger of conveyor is completely enclosed to avoid product from contacting unfiltered air.

Key definitions for spray process powder (§ 590.544(a)):

- Primary powder is the powder that is continuously removed from the primary or main drying chamber while the drying unit is in operation.

- Secondary powder is that powder that is continuously and automatically removed from the secondary chamber and/or bag collector chamber while the drying unit is in operation.

- Sweep-down powder is that powder which is recovered in the brush-down process from the primary or secondary chamber and conveyors.

- Brush bag powder is that powder which is brushed from the collector bags.

As per § 590.544(b), secondary powder should be continuously discharged and mixed with the primary powder using approved methods.

Key spray process drying facilities and operations regulatory requirements include (Spray Process Drying Facilities and Operations – § 590.540/590.542):

1. Driers shall be of a continuous discharge type and so constructed and equipped to prevent an excess accumulation of powder in the drier, bags, and powder conveyors.

2. Driers shall be of approved construction and materials, with welded seams and the surfaces shall be smooth to allow for through cleaning.

3. Driers shall be equipped with approved air intake filters

4. Air shall be drawn into the drier from sources free from foul odors, dust and dirt

5. High-pressure pump heads and lines shall be of stainless steel construction or equivalent which will allow for thorough cleaning

6. Powder conveying equipment shall be so constructed as will facilitate thorough cleaning

7. Sifters shall be constructed of an approved metal or metal lined interior. Sifters shall be so constructed that accumulations of large particles or lumps of dried eggs can be removed continuously while the sifters are in operation.

8. The drying room shall be kept in a clean condition and free of flies, insects, and rodents.

9. Low-pressure lines, high-pressure lines, high- and low-pressure pumps, homogenizers, and pasteurizers shall be clean by acceptable in place cleaning systems or dismantled and cleaned.

10. Spray nozzles, orifices, cores, or whizzers shall be cleaned immediately after cessation of drying operations.

11. Equipment shall be sanitized within 2 hours prior to resuming operations.

12. Dry units, conveyors, sifters and packaging systems shall be cleaned whenever wet powder is encountered.

The dried egg product must be handled aseptically during packaging. The advantages of dried egg products compared to their liquid frozen counterparts are shelf life, storage, and low transportation costs.

Reconstitution of spray process powder (§ 590.544(d and e)

Reconstitution means to restore to the previous condition of the dried egg product by adding water. Any edible dried egg powder may be reconstituted, repasteurized, and redried in a sanitary manner, in accordance with prescribed procedures (§ 590.544(d)). Edible dried egg powder obtained from the sweep down, screenings, brush bag (except for brush bag powder from albumen driers) and improperly dried or scorched powder shall be reconstituted, pasteurized, and then re-dried (§ 590.544(e)).

Powder is to be thoroughly reconstituted to at least the solids content of the original pasteurized liquid or lower. Dried products, which had a total solid of 32% or higher in the liquid form, need to be reduced to a solid content lower than the original liquid product. Improperly reconstituted product particles or high solids in the reconstituted liquid can provide protection to *Salmonella* and may contribute to inadequate pasteurization.

Edible dried product may be blended only in a closed system (§ 590.544(c)) in accordance with clean and sanitary practices using approved procedures.

Pan Drying

The other method for producing dried egg products is *pan drying* – this method consists of drying the unpasteurized egg whites on pans to produce a flake-type material. The pan-dried egg white can be sifted to produce the flake and granular dried product or pulverized to produce the milled powder type of product.

The following two regulations outline the requirements for the albumen flake process drying.

- § 590.546 – Albumen flake process drying facilities
- § 590.547 – Albumen flake process drying operations

Heat Treatment of Egg Whites – § 590.575

9 CFR 590.575 outlines the requirements for heat treatment of dried whites and provides for approval by the Administrator of other acceptable methods of heat treatment upon satisfactory evidence that such methods will result in *Salmonella*-negative product (§ 590.575(b)(3)). Heat treatment of dried whites is an approved method for pasteurization. The product must be heated throughout for such times and at such temperatures as will result in *Salmonella*-negative product. The regulation defines the requirement for the heat treatment of dried egg albumen.

- The product to be heat treated (spray or pan dried – with lot number or production code number) shall be held in the heat treatment room in closed containers and shall be spaced to ensure adequate heat penetration and air circulation (§ 590.575(a)).

- Spray dried albumen shall be heated throughout to a temperature not less than 130º F and held continuously at such a temperature not less than 7 days, based on a moisture content of 6-8%, and until it is *Salmonella*-negative (§ 590.575(b)(1)).

  Note: Studies has demonstrated that heating spray dried albumen to 152.6º F (67º C) with 7.5% moisture throughout and holding at that temperature for 10 days will inactivate HPAI. *Salmonella* pasteurization heat treatment processes for spray-dried egg whites are adequate to inactivate HPAI (refer to askFSIS Q&A published – FSIS website; Avian Pathology (2004) 33: 512 – 518; J. Food Protection (2009), Vol 9:1997 – 2000; World Organization for Animal Health (OIE)(2014), available at http://www.oie.int/fileadmin/Home/eng/Health_standards/tahc/2010/en_chapitre_avian_influenza_viruses.htm).

- Pan dried albumen shall be heated throughout to a temperature of not less than 125º F and held continuously at such a temperature not less than 5 days and until S*almonella*-negative (§ 590.575(b)(2)).

As mentioned earlier, the minimum product temperature and holding time is based on a moisture content of 6-8%. The heat resistance of *Salmonella* increases as the moisture content of the dried product decreases; thus requiring an increase in holding time and/or temperature (has to be approved as per § 590.575(b)(3)). The results of moisture analyses are to be made available to IPP. Recording thermometers shall be placed in product containers and shall record continuously throughout the holding process to ensure the minimum holding temperature. In addition, the plant has to comply with § 590.575(c) – (e):

- All records associated with this process must be kept for one year and must include all the required information.

- All products must be tested and confirmed negative for *Salmonella*.

- At the time of the negative test, this product may be labeled "Pasteurized."

FSIS inspection is not required during the dried egg whites heat treatment period present provided that the plant is not conducting any other processing activity that expects an inspector to be on duty (refer to askFSIS Q&A entitled "Coverage of Egg Products Plants-Heat Treatment of Dried Egg Whites" – FSIS website). IPP must:

- Be present at the beginning and end (removal of dried egg product from the hot room) of the heat treatment. Verify the accuracy of thermometers and thermocouple records.

- Verify that the heat treatment procedures throughout the holding cycle and at the end of the process have met the regulatory requirement of § 590.575. The product is to be heated throughout to the minimum required temperature and held at that temperature (or higher) for the minimum holding time or longer. Records should reflect the room temperature and log of thermometer readings from thermometers located throughout the room, internal product temperature of various lots, dates the lots were placed/removed from the heat treatment room, time product was held, etc. Plant records must be checked as often as necessary to ensure continuous compliance.

- Verify the moisture content and anti-caking ingredients used in each lot and that the product complies with the standard of identity (21 CFR 160) before shipment into commerce.

- Verify that the plant sampled the product and tested for *Salmonella*

Final Product Inspection

A final condition inspection is also required on each lot of frozen egg products prior to shipment (§ 590.536(e)).

A condition inspection of liquid and dried egg products prior to shipment, involves the following:

- Examining a minimum of two containers from each lot of each type of product category produced during the shift. Products may be grouped into two categories:
    - Yellow products – including whole eggs, yolks, and various blends with or without ingredients
    - Egg whites – including imitation and substitute egg products inspected under the voluntary program.

- Performing an organoleptic inspection.

For frozen products, ensuring product is adequately frozen (see below).

Organoleptic inspection is done during the process of packaging or after packaging/storage. IPP will deem the odor of the product to be either satisfactory or unsatisfactory. The following describes these two classifications.

Satisfactory Odors	**Unsatisfactory Odors**	
Bland	Chemical	Moldy
Eggy	Fuel Oil	Musty
Stale	Sour	Putrid
Storage	Smoke	

If the product passes this final examination, it is eligible to be shipped. If any foreign material or if any unsatisfactory odors are detected, the product is considered off condition and unacceptable for human use.

Inspection of Frozen Product for Condition and Adequacy of Freezing

Products labeled as frozen must be solidly frozen or reduced to a temperature of 10º F or lower within 60 hours of pasteurization (§ 590.536(a)) or the time specified in the waiver. Salted or sugared egg product may not become solidly frozen. For these types of products, the internal temperature must reach 10º F or less.

The requirements for freezing and freezing facilities are found in § 590.534 and § 590.536 of the egg products inspection regulations and must be met by official plants. As soon as practical, after the 60-hour period or the time specified in the waiver has elapsed, samples from each lot of each type product in each type (size) of packaging material should be examined for condition and adequacy of freezing. IPP are to:

- Observe the appearance of the frozen product.

  - If product is frozen in less than 60 hours, the final inspection can be performed as soon as the product is frozen.
  - Frozen products with “flat tops,” “rounded humps,” or a darker than normal color, are to be reported to plant management and the inspector’s immediate supervisor. Such conditions are indicative of a slow freeze, and these products may have a greater potential for being incompletely frozen or off condition; take regulatory action if warranted.

- Verify that the product is properly spaced in the freezer so that air can circulate around each individual container.

- Follow instructions according to EPIH, Section 5, VI B and C (pages 38 – 40)

Products are tested for adequate freezing by drilling into the frozen product and taking out samples. The sampling procedure and frequency is based upon the plant’s history in successfully freezing product.

Please note that for safety purposes, FSIS requires the plant to drill the egg products. The inspector should ensure that plant personnel do not drill into samples from packages or containers that are less than 2-inches thick or that weigh less than one pound. If containers are too small for drilling, the inspector will perform an organoleptic examination. It is recommended that product be defrosted by running cool water over the product or by any other acceptable method.

If product is not frozen within 60 hours or time specified in a waiver, the inspector should perform an organoleptic inspection. If the product is not off-condition, the plant can propose immediate actions to ensure the product becomes adequately frozen and thus eligible for shipment.

The EPIH provides detail on how to sample frozen product for condition and to determine the adequacy of freezing, organoleptic examination, etc. (Section 6, E G - I; pages 12 – 19).

Off Condition Product

Product contaminated with foreign material or which has any degree of unsatisfactory or other objectionable odor is not acceptable for human food, therefore, is considered off condition.

If product is found to be off condition—for example, sour—the inspectors are to take the steps outlined below.

1. Retain the entire lot from which the off-condition product has come.

2. Inform plant management and inspection supervision of the lot amount and location of the product. Document this information in PHIS as a regulatory noncompliance, including the description of the unsatisfactory odor, under the appropriate food safety task (you will learn more about this in the Egg Products PHIS Training). If plant management requests re-examination of product that has failed final inspection for off condition, FSIS may grant authorization for container-by-container re-examination.

3. Ensure the identification of applicable pallets.

4. Verify container-by-container segregation. If a significant number of containers are rejected, the supervisor may decide not to accept a container-by-container examination and reject the whole lot. In this case, the product would be determined ineligible for human consumption and the plant would be expected to divert the product to inedible if inspection kept it under retention.

   Note: If the product is at an off-premises freezer, the company would need to determine the appropriate disposition unless the product is approved forsalvage. It would then need to be returned to an official plant.

5. Following segregation, remove or obliterate all official identification from all containers of unsatisfactory product. This product must be identified as inedible and the product must be denatured or placed under retention pending shipment as non-denatured inedible.

Please note that the Documentation and Enforcement Module provides more detail on how to take and document these enforcement actions.

Shipping

As mentioned earlier, plants may also ship liquid egg products to another official egg products plant (under seal and certificate). Liquid egg products shipped to another official egg products plant must meet specific regulatory temperature requirements at the time of shipping. These temperature requirements are in 9 CFR 590.530(c) Table 1 – *Minimum Cooling and Temperature Requirements for Liquid Egg Products.*

Two factors determine the specific temperature that the egg products must meet at the time of shipping:

- The amount of time between when the product is produced or processed by the origin plant. The clock begins at different times, depending on

what processes the liquid egg product undergo. Each time the product goes through a processing step, the clock resets to zero.

- Whether it has 10 percent or more salt added to the product.

Temperature Requirements for Liquid Eggs Destined for Shipping

Time Between Processing or Pasteurizing	Liquid Eggs with ≤10% Added Salt	All Other Liquid Eggs
Less than or equal to 8 hours		45° F or less
Greater than 8 hours		40° F or less
Less than or equal to 30 hours	65° F or less	
Greater than 30 hours	45° F or less	

Note: these temperatures are the cooling requirements before the product is shipped but does not apply when products arrive at the receiving official plant.

The equipment used to process or load product may raise the temperature of the egg products because of the friction generated by that equipment in use and temperature conditions inside the tanker. Product in tankers that ship during spring and summer may have a higher temperature because of higher ambient air temperature during transportation. So, plants should consider the processing and shipping conditions when they reduce product temperature before shipping.

You will verify that the plant meets this regulatory requirement after the product is processed or pumped and before the product is shipped.

Section § 590.42(b) requires all egg products to be reinspected by IPP when they are brought to an official plant. At the receiving end, the inspector should conduct an organoleptic examination and temperature check of the egg products to ensure that the product is not “off-condition”.

Tanker Inspection

As stated earlier, the tanker must meet the regulatory sanitary requirements of 9 CFR 590.504(k) and 590.522(y) before loading the egg product.

If the plant has safe access to the dome for inspection, once the egg product is loaded, the inspector will perform an organoleptic inspection and personally apply the USDA seals (as applicable). A certificate is to be completed (Form PY-200; see Attachment 1) only after the product is loaded and the inspector has checked it.

If the plant does not have safe access to the dome, the inspector will not be required to climb atop egg product transport tankers to inspect the units. This is true whether inspection occurs at the originating plant or the receiving plant. This safety measure for FSIS inspection program personnel was introduced in a memorandum issued by Field Operations on January 27, 2000. The memorandum further requests plant management to make plant personnel available to do the following in the presence of the inspector:

- apply and break seals
- collect all samples
- present the seal and samples to IPP for organoleptic evaluation or laboratory analysis

The plant may elect to devise an acceptable method of collecting samples to meet inspection objectives. The inspector will execute all required documents as usual.

For additional detail on documentation and enforcement efforts, see the “Documentation and Enforcement” section.

Returned Product

All returned egg product brought into the official plant needs to be examined by the inspector for condition and wholesomeness (§ 590.424(b)).

Plant management must inform the inspector when such product enters the plant. Plant management must keep a record of the following information:

- Identity and state of the product
- Name and address of the packer or distributor
- Plant number
- Lot number
- Number of containers
- Date received
- Date examined
- Condition of the product and disposition

After doing organoleptic inspection and reviewing records, the inspector must determine compliance or noncompliance with the 9 CFR part 590 regulations. The inspector must then:

- Take appropriate actions
- Enter the inspection verification results in PHIS using the appropriate food safety task and document any noncompliance found.

Plant Operations Workshop

Working with your group, use the handout and the appropriate regulatory references to answer these questions.

1. What action should an inspector take if he or she finds solid mold on a shell egg in the transfer room?

2. What does “ppm” stand for?

3. What are the ppm requirements for sanitizing eggs?

4. Liquid egg product has been pasteurized and is to be held for 9 hours. At what temperature must it be held?

5. What are the minimum pasteurization values for plain yolk?

6. What does reconstitution mean?

7. What are the satisfactory and unsatisfactory odors for egg products?

8. Are FSIS inspectors allowed to drill frozen product? Explain your response.

9. What steps should be taken if product is considered off condition?

Noncompliance with pasteurizer hold-time

Scenario

In a given day the plant will be pasteurizing liquid whole egg product using the time/temperature requirements of 590.570(b).

Given the following information:

- Holding tube length is 678 ft.
- Diameter of holding tube is 3 inches
- One foot of 3 inch holding tube holds 2.90 lbs. of liquid whole egg

- Total capacity in lbs. of holding tubes is calculated as:

  678 ft. multiplied by 2.90 lbs. is equal to 1,966 lbs.

- Maximum permissible flow rate in lbs. for a 3.5 minute hold at 140^0F (§ 590.570(b)) is calculated as:

  1,966 lbs. divided by 3.5 minute maximum hold is 561.77 lbs. per minute

- Hold-time calculation when flow rate of 547.6 lbs. of whole egg. per minute is known:

  1,966 lbs. divided by 547.6 lbs. flow rate for 1 minute catch is 3.59 minutes hold which is greater than the minimum hold time of 3.50 minutes.

When pasteurization of the lot was nearly completed, it was determined that the actual flow rate had increased to 571.6 lbs. per minute.

Thought process:

How does that affect our calculation?

> 1966 lbs. divided by 571.6 lbs. per minute gives a flow rate of 3.44 minutes of holding time, which is too short to meet the regulatory requirement of 9 CFR 590.570(b) which is 3.50 minutes of minimum holding time at 140^0F.

Is this a noncompliance? ***YES***

In this non-compliance, the flow rate was discovered to be inaccurate after the operation began and the minimum holding time was less than 3.50 minutes.

That means that the pumps were sending the egg through the holding tubes 24 lbs. per minute faster than had been previously calculated (571.6 lbs. – 547.6 lbs. = 24 lbs.). Therefore, the flow rate needs to be reduced or the holding tube length increased.

The product is then required to be pasteurized again at an acceptable hold time and temperature requirement according to 9 CFR 590.570(b).

Key concepts

1. Catch as large a quantity for the longest period of time possible in order to more accurately determine the flow rate used to calculate holding time to verify pasteurization system adequacy with respect to § 590.570(b).

2. Do not round up and you will have a safety margin in your calculations.