

CHEESE – PASTEURIZATION

Solutions Sales Training Reference

Receiving

Pasteurization

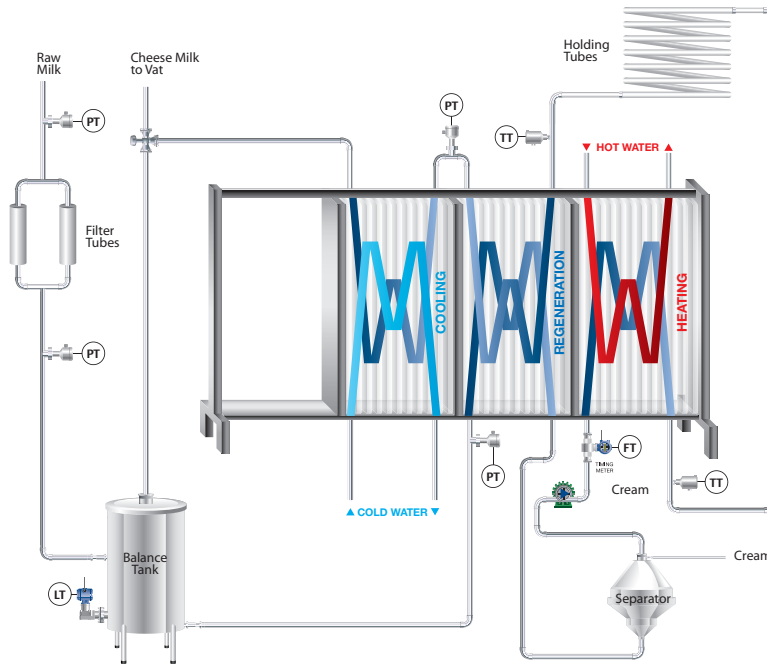
Standardization

Cheese Vat

Starter Room

Finishing

CIP



Key Objectives:

- Adequately pasteurize the milk to destroy pathogens
- Reduce rework to minimize cost per pound
- Achieve proper temperature for downstream processing (depends on type of cheese)

Pasteurization Process Description

Pasteurization is the heat treatment of milk to destroy pathogenic bacteria. Colling milk prevents bacterial growth, but heating is required to destroy the bacteria introduced in milk production. Two types of pasteurization are common:

- High Temperature Short Time (HTST) common in the United States.
- Ultra High Temperature (UHT) common in Europe.

The temperature used for pasteurization affects the shelf life of the product as well as the taste and appearance. This section will deal with HTST pasteurization. Raw milk from the storage silos is filtered to remove impurities (often called “clarification”) and sent to an intermediate tank known as a balance tank. Once the raw milk leaves the balance tank it is ready for pasteurization. It is heated in a series of plate heat exchangers set up in 2-4 sections. Most plants have at least three: Regeneration, Heating and Cooling. Raw milk is first preheated in the “Regeneration” section. It is labeled regeneration because it uses hot milk out of the pasteurizer as the heating medium, thereby accomplishing two objectives:

preheating raw milk and cooling the pasteurized milk. The preheated raw milk is sent to a separator, where cream is drawn off and sent elsewhere for processing. Please reference the section labeled “Separation and Standardization” for more details on separation. The preheated (and standardized) milk is sent to the heating section, where it is heated to correct pasteurization temperature, typically 72°C (162°F). Flow to this section is carefully measured, since it determines the holding time. Milk flows out of the heating section into a long, coiled tube called a holding tube that gives the appropriate retention time. The relationship between time and temperature used for pasteurization is carefully regulated to ensure lethality of pathogens. For HTST, milk is typically held at 72-73°C (162-164°F) for 15-20 seconds. Any milk coming out of the holding tube that is processed outside regulated time and temperature requirements is diverted to the balance tank and reprocessed. See Table 2 for U.S. FDA approved time vs. temperature curves.

After milk exits the holding tube and the temperature is verified, it again enters the Regeneration section, but this time it is being cooled (by transferring heat to the raw, un-pasteurized milk). It then flows to the cooling section of the heat exchanger where cold water cools it to the proper “cheese-milk” temperature. For cheddar, one cooling section is often enough since the temperature of the milk should be 88°F (31°C). For Mozzarella, the temperature is 92-98°F. More cooling sections are required for butter and sweet cream, since those temperatures should be 50°F and 38°F, respectively. If this temperature falls below setpoint, there is a blend valve that allows hot milk from the holding tube to be added to the cooled milk.

Cream pasteurization is handled in the same way in a different area of the plant, unless the dairy sells the cream unpasteurized. Plants have many silos to handle the separated and standardized cream and milk for both pasteurized and unpasteurized cream and milk, these silos are typically in the same alcove as the receiving silos.

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Select Measurement and Control Points in Pasteurization

Pasteurization Time and Temperature

Managing pasteurization time and temperature is the most critical loop in a dairy plant. Milk must be processed at a given temperature for a given length of time to destroy pathogens, and must be proven. If not, the milk must be reprocessed. That means higher cost per pound of cheese produced. Over-heating results in loss of quality and lower yield.

Heat Exchanger Differential Pressure

Local health regulations require the dP across the regenerative heating section of the heat exchanger to be at least 1psi to prevent raw, unpasteurized milk from contaminating pasteurized milk in the event of a plate breach. A pressure device is placed on the pasteurized milk out of the holding tube, and another is placed on the raw milk. If the dP falls below 1psi, the milk is diverted and reprocessed, creating higher costs per pound of production.

Cheese Milk Temperature

Milk in the last stage of the heat exchanger is cooled to temperatures specific to the type of cheese being produced. Stable temperature control facilitates critical processes downstream.

Table 2. FDA Pasteurized Milk Ordinance (PMO) requirements for pasteurization time and temperature.

Temperature	Time
63°C (145°F)	30 minutes
72°C (161°F)	15 seconds
89°C (191°F)	1.0 seconds
90°C (194°F)	0.5 seconds
94°C (201°F)	0.1 seconds
96°C (204°F)	0.05 seconds
100°C (212°F)	0.01 seconds

Pasteurization Time

Control Point Challenge:

The flow rate to the heating section of the pasteurizer determines the pasteurization time in the holding tube (given a set tube length) and must comply with local health regulations. In the U.S. pasteurization is regulated by the FDA Pasteurized Milk Ordinance (PMO).

Solution:

Magnetic flowmeter based timing systems have replaced positive-displacement timing pumps to determine raw milk flow into the heating section of the pasteurizer (just after the separator). The hygienic magmeter must be repeatable and produce a holding time within 0.5 seconds of the required 15-16 seconds.



Rosemount 8721 Magmeter

- PMO approved (M-b 350)
- 3-A and EHEDG approved
- 0.25% accuracy
- Isolated electronics and LOI for long term reliability

Pasteurization Temperature

Control Point Challenge:

The heating section of the pasteurizer uses hot water to control pasteurization temperature. The hot water is typically set 2-3°C above the pasteurization temperature to prevent scalding. Failure to correctly measure and control this point leads to costly rework, since the milk would be diverted back to the balance tank and reprocessed.

Solution:

The temperature of milk out of the heating section (going to the holding tube) is carefully measured. If this temperature starts to drop, a steam valve is activated on the hot water system to ensure the temperature reading at the outlet of the holding tube does not drop below local regulated health requirements.



Rosemount 644 Temperature Transmitter & 68Q Hygienic Sensor

- 3-A and EHEDG sensors
- Sensor matching for best accuracy
- Sensor drift alerts

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Pasteurization Temperature Divert Sensor

Control Point Challenge:

The temperature of pasteurized milk out of the holding tube is carefully measured and recorded for regulatory requirements. If the temperature falls below pasteurization temperature the milk must be reprocessed, which adds significant cost and may affect production. If the temperature is too high, the plant loses yield and quality could be affected since it will denature the protein bonds.

Solution:

A temperature sensor at the outlet of the holding tube is used to prove milk was pasteurized at the proper temperature, since pasteurization time is held constant. If the temperature drops below regulatory requirements, the milk is diverted back to the balance tank for reprocessing.



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Filter Plugging

Control Point Challenge:

Prevent milk from plugging filters out of the raw milk silo.

Solution:

Filters run as a redundant pair, so filter plugging typically does not interrupt the process. One pressure device is used before both filters and one after to detect an increase in differential pressure. The plant can seamlessly switch filters and wash the plugged filter.



Rosemount 4500 Temperature Transmitter

- Designed for Food and Beverage
- Small, stable, and reliable
- Conforms to 3-A and EHEDG standards.
- Withstands CIP and wash-down.

Balance Tank Level

Control Point Challenge:

The pasteurizer must be full at all times to prevent milk from burning on the plates.

Solution:

The balance tank level is measured to prevent costly overflow (and loss of product) as well ensure a stable supply of milk to the pasteurizer to prevent burning on the plates. A low level switch will divert the milk out of the pasteurizer and into the balance tank when the level is too low. Balance tanks are typically 18-25" high.



Rosemount 3051S DP Level Transmitter

- 12 year warranty (10 year stability)
- Lowest total cost of ownership
- Variety of hygienic tank connections



Rosemount 2100 Level Switch

- Reliable vibrating fork technology
- Unaffected by turbulence, foam, bubbles or vibration.
- No moving parts; virtually maintenance free.

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Regenerative Heating Differential Pressure

Control Point Challenge:

To prevent raw, unpasteurized milk from contaminating pasteurized milk in the regeneration section of the heat exchanger (in the event flaws develop in the metal or joints of the plate), a differential pressure must be maintained with the pasteurized milk on the high side (so flow will be from pasteurized milk to unpasteurized).

Solution:

A pressure device on the raw, untreated milk (at lower pressure) and a device on the pasteurized milk (kept at a higher pressure) is used to keep the differential above 1 psi to prove that in the case of a plate breach the milk will always flow from the pasteurized side to the unpasteurized side. Most plants maintain an 8-10 psi differential, with line pressures at 20-30 psi.



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- Withstands CIP and wash-down.

Balance Tank Level

Control Point Challenge:

The pasteurized milk must be cooled to a specified temperature based on type of cheese being produced before it is sent to the next process area.

Solution:

The cooling section of the pasteurizer typically uses cold water to control the final milk temperature. This outlet temperature activates a control valve to regulate the amount of coolant used. If the cheese milk falls below the desired temperature, a separate diversion valve (located after the holding tube but before the heat exchanger) will divert hot milk to the finished milk.



Rosemount 644 Temperature Transmitter & 68Q Hygienic Sensor

- 3-A and EHEDG sensors
- Sensor matching for best accuracy
- Sensor drift alerts

Steam to Heating Water

Control Point Challenge:

Hot water used to pasteurize milk is heated by steam via a small heat exchanger. By measuring totalized steam flow, anomalies in energy use can be detected and used to optimize performance of the pasteurizer. This measurement also aids in overall energy management for the cheese plant.

Solution:

A mass flow measurement will enable totalized steam flow for the pasteurizer based on hour, shift or day. Trending of this information will provide visibility to exceptions where steam use is out of line, indicating a problem with the equipment. It can also be used on overall plant energy management.



Rosemount 3095 MF Mass Flow Meter

- Multivariable: flow, P, T, DP
- 1% mass flow accuracy with up to 10:1 turndown
- Pressure and temperature compensation



Rosemount 8800MV Mass Flow Vortex

- Multivariable: flow and T
- 2% accuracy with up to 30:1 turndown
- Temperature compensation for saturated steam
- Process isolated removable temperature sensor