THE DAIRY PRACTICES COUNCIL®

BEST PRACTICES FOR CHEESE BRINE SYSTEMS

MATERIALS, CONSTRUCTION, & MAINTENANCE

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Prepared by:

PLANT EQUIPMENT & PROCEDURES TASK FORCE

Amy Rhodes, Director

Philip Wolff, Lead Author

With Assistance from Greg Leach

Sponsored by:

THE DAIRY PRACTICES COUNCIL®

Christopher Hylkema, President

Keith Hay, Vice President

Steve Murphy, Executive Vice President

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ABSTRACT

This guideline provides information on materials of construction, fabrication, and installations of cheese brine systems based on the USDA publication *USDA Guidelines for the Sanitary Design and Fabrication of Dairy Processing Equipment* and other resources. It also covers best practices for maintaining cheese brine quality.

PREFACE

This guideline was prepared by Philip Wolff, USDA, Dairy Grading Branch (retired), with assistance and information provided by additional members of the USDA staff. Additional review and input provided by Greg Leach, Losurdo Foods.

GUIDELINE PREPARATION AND REVIEW PROCESS

The Dairy Practices Council (DPC) Guideline development and update process is unique and requires several levels of peer review. The first step starts with a Task Force subcommittee made up of individuals from industry, regulatory and educational institutions interested in and knowledgeable about the subject to be addressed. Drafts, called "white copies," are circulated until all members of the subcommittee are satisfied with the content. The final "white copy" may be further distributed to the entire Task Force; DPC Executive Board; state and federal regulators; educational and industry members; and anyone else the Task Force Director and/or the DPC Executive Vice President feel would add strength to the review. Following final "white copy" review and corrections, the next step requires a "yellow cover" draft to be circulated to representatives of participating Regulatory Agencies referred to as "Key Sanitarians." Key Sanitarians may suggest changes and insert footnotes if their state standards and regulations differ from the text. After final review and editing, the Guideline is distributed in the distinctive DPC "green cover" to DPC members and made available for purchase to others. These guidelines represent our state of the knowledge at the time they are written. Currently, DPC Guidelines are primarily distributed electronically in pdf format without colored covers, but the process and designation of the steps remains the same. Contributors listed affiliations are at the time of their contribution.

DISCLAIMER

The DPC is not responsible for the use or application of the information provided in this Guideline. It is the responsibility of the user to ensure that the information addresses their needs and that any action taken complies with appropriate regulations and standards.

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INTRODUCTION

The control of cheese brine quality is important for many varieties of cheese, where salt is added to the cheese basically by soaking the cheese blocks in a "brine" or salt solution for a specified time, at a specified temperature. Cheese brining system designs vary depending on the size of the cheese manufacturer and the cheese variety and required brining time. Examples of design options include:

- *Batch systems* – adaptable to small scale cheese makers. Brine tanks may be placed in a cooler to maintain desired temperature.
- *Continuous systems* – used on larger scale, with manual or fully automated feeding and removal of cheese blocks. Designs include tank and flume type systems.
- *Static tank systems* – brine is contained in a holding tank, with cheese placed and removed after the required hold time. May be set up for batch or automated continuous operation (in one side of tank, out the other). Ideally, systems should be set up with brine circulation, filtration and temperature control.
- *Flume or channel systems* – typically consists of narrow channels where cheese blocks move forward in flowing, recirculated brine, often in a serpentine configuration. Most often used for shorter brining times. Ideally, systems should be set up with brine circulation, filtration and temperature control.
- *Shallow or surface brining* – cheese is brined in single layers and typically requires a mechanism to periodically submerge the floating cheese blocks (e.g., rollers) or to spray the upper surface of the cheese. Flume systems are typically shallow.
- *Deep brining* – cheese blocks are layered into hoisted cages with multiple layers or into racks; as one layer is filled it is submerged and the layer above is subsequently filled until all layers are full and submerged. Because the loading time for each cage may vary substantially from top to bottom, these systems are most often used for longer brining times.

Regardless of the specific system design, brine systems must be manufactured, installed, and maintained in a sanitary manner to minimize contamination of the cheese and to ensure that brining conditions are favorable for the specific cheese. This guideline provides an overview of requirements for the fabrication, installation and maintenance of brine systems, and is based primarily on USDA guidance documents for facilities that manufacture dairy products; state and other appropriate regulatory agencies should be consulted for additional requirements. The referenced USDA documents and other resources are listed at the end of the guideline. This guideline also covers practices for monitoring and maintaining the quality and safety of the brine.

MATERIALS

Brine tanks and associated equipment must be constructed of suitable nontoxic material and should be resistant to corrosion, pitting or flaking. Stainless steel, fiberglass-covered wood, fiberglass reinforced plastic (FRP), sanitary ceramic tiles, good condition concrete, or other suitable nontoxic materials are satisfactory. Stainless steel is considered the industry standard for sanitary design. Because of the strong corrosive effect of brine on most metals and paint, the tank exterior surfaces, legs, or other framework should also be constructed of stainless steel, fiberglass-covered wood, or other corrosion resistant materials.

Since brine is very corrosive to ferrous metals, the piping used for recirculating the brine solution should be constructed of stainless steel, approved plastic, or rigid polyvinyl chloride (PVC) piping.

EQUIPMENT FABRICATION, DESIGN AND INSTALLATIONS

Generally, equipment used in brine systems, including tanks, piping, valves, pumps and accessories may be of design and materials that meet the criteria for manufacturing grade milk handling and processing systems, provided the materials withstand potential corrosion. Because of the nature of brine systems and the brining process, additional requirements, exceptions or allowances may apply. Following are USDA requirements, with added notes as applicable.

Piping, Valves, Pumps

1) *Piping* - brine piping must be rigidly supported and self-draining. Plastic or rigid PVC piping and associated adhesives suitable for potable water systems may be used for the transport of brine.

2) *Fittings* - threaded fittings may be used for brine spray nozzles. *Note (input from NY Regulatory)*: Threaded fittings generally are not considered to be of sanitary design and should not be used on equipment that will be cleaned by recirculation methods. Manual cleaning is required.

3) *Valves* - butterfly type valves are acceptable for use on brine distribution piping, in addition to standard sanitary dairy valves. *Note (input from WI Regulatory)*: butterfly valves of most designs require disassembly and manual cleaning and are typically discouraged in many sanitary applications in dairy processing.

4) *Pumps* - pumps that comply with the 3-A *Accepted Practices for Permanently Installed Product and Solution Pipelines and Cleaning Systems Used in Milk and Milk Products Processing Plants*, Number 605-04, for circulating cleaning solutions are satisfactory.

Specially constructed Archimedes screw or jet type pumps may also be used, provided that the construction materials are corrosion resistant and there are no lubricated bearings directly above or submerged in the brine. All motors, drive assemblies, lubricated bearings, and other potential sources of contaminating substances, must be appropriately isolated or shielded to prevent contamination of the brine.

Brine Tanks & Flumes - Materials & Design

1) *Stainless steel tanks* - should be made from 316 series stainless steel. A "2B" mill finish is satisfactory. All welds must be continuous, snag and pit free. There are no minimum radii requirements for internal angles under USDA requirements. *Note (input from NY Regulatory)*: Product contact surfaces need to be of proper sanitary design to wash effectively; proper sanitary design requires that all internal angles of less than 135° shall have radii of ¼ inch.

2) *Concrete or concrete coated tanks* - must have a smooth, cleanable interior surface. Exposed aggregate, pockets, bubbles, form impressions, flaking, or galling of the surface (surface to surface wear by friction and adhesion resulting in gouging or balled up material) is unacceptable. If a coating or sealer is used, it must comply with the applicable FDA requirements for indirect and repeated food contact (21 CFR PART 174 - *Indirect Food Additives: General*).

3) *Ceramic tile covered tanks* - must have a smooth, cleanable interior surface. Missing grout, flaking or galling of the surface is unacceptable. If a grout sealer is used, it must comply with the applicable FDA requirements for indirect and repeated food contact (21 CFR PART 174 - *Indirect Food Additives: General*).

4) *Fiberglass tanks & brine systems* - must have surfaces that are at least as smooth as a good condition concrete tank. Fiberglass tanks should not possess rough, pitted surfaces, fabric folds, or exposed fibers. Fiberglass tanks and components must be constructed with a final, resin rich coating that results in a smooth cleanable surface, free of pits, checks, cracks, ripples or waves on both the interior and exterior surfaces. The design and construction of wooden frames, legs, or other structural components for fiberglass tanks must be able to bear the weight loading without stressing or breaking the fiberglass coating when the tank or flume system is filled with brine. All openings, bored holes

for pipe or conduit passage, cut outs, or attachments to the fiberglass surfaces of the tank must be fully sealed or fiberglass covered to prevent the entrance of moisture into the wooden frame.

5) *Approved plastics* - Plastic materials shall comply with 21 CFR PART 177 - *Indirect Food Additives: Polymers*.

Note: Bins, tubs or trays purchased for small scale, batch brine applications should be purchased from companies that specifically supply such items designed and approved for food applications. If such items are purchased from a general retail store, it is recommended that the manufacture be contacted and asked to provide a letter confirming that materials are food grade and acceptable for brining use.

Drainage

Provision must be made so the brine can be pumped out of the system so the tanks or flumes can be cleaned. Separate brine storage tanks or product storage tanks may be used.

Brine Tank Placement & Clearance

Brine tanks may be placed above the floor as individual tanks or stacked or placed below the floor level (Pit tanks). They may be mounted directly on the floor if installed correctly and maintained.

1) *Stacked or piggy-backed tanks* - brine tanks may be mounted one atop the other, provided the exterior of the top tank is constructed to the same specifications as the product contact surfaces of the tanks. Regular checks for cleanliness and the presence of mold on the underside of the tanks are also needed. When tanks or flumes are stacked, or piggy-backed, sanitary means must be provided for access to the upper tanks; employees must not stand on the edge of the lower tank. Sanitary procedures must be established and followed when working with or cleaning the top tank, as well as the bottom tank.
2) *Pit tanks* - pit tanks of any material, must have perimeter walls or curbs that extend at least 12 inches (305 mm) above the floor level of the room.

Clearance

1) *Walls* - the perimeter clearance between a tank or flume system and the walls of the room must be at least 24 inches (610 mm).
2) *Between tanks* - the aisle spacing between adjacent tanks must be at least 24 inches (610 mm), except that two long rectangular shaped tanks may be butted against each other on the long side in accordance with the following criteria:
   a. There is at least 24 inch (610 mm) aisle clearance on the remaining four sides.
   b. The upper crevice between the two tanks is appropriately sealed.
   c. The underside contact points are properly sealed and form a flush surface with the bottom of the tanks. Deep recesses created by tank lips are unacceptable.
3) *Tank bottom and floor* - the clearance distances between the bottom of a tank and the floor based on *tank width* are as follows (applies to single level tanks / flumes, and the bottom tank of stacked tanks):

Tank Width in Feet (meters)	Minimum Clearance in Inches (millimeters)
Up to 3 ft. (0.9 m)	12 in. (305 mm)
3 to 6 ft. (0.9 - 1.8 m)	20 in. (508 mm)
6 to 8 ft. (1.8 - 2.4 m)	24 in. (610 mm)
10 to 12 ft. (3.0 - 3.7 m)	26 in. (660 mm)
12 to 14 ft. (3.7 - 4.3 m)	28 in. (711 mm)
14 to 16 ft. (4.3 - 4.9 m)	30 in. (762 mm)
Over 16 ft. (4.9 m)	36 in. (914 mm)

Note: All tank measurements are exclusive of projecting ribs, cross beams, or top lips. Alternatively, tanks or flumes can be mounted directly on the floor, see below.

4) *Ceiling* - the distance between the uppermost tank top lip and the ceiling of the room must be at least 18 inches (457 mm). If there are ceiling joists or beams projecting downward, there must be compensating clearance to facilitate manual cleaning.

5) *Stacked tanks* - the distance between each tank and any tank above it (stacked or piggy-back tanks) must be at least 18 inches (457 mm), as measured between any projections or cross beams of the upper tank and the top lip of the lower tank except that:

   a. if the upper tank has ribs or cross beams that project downward 12 or more inches (305 mm), the clearance must be 24 inches (610 mm);

   b. if the bottom tank is divided into narrow flumes less than 20 inches (508 mm) wide, which interfere with movement in the bottom tank for manual cleaning, the clearance must be 24 inches (610 mm).

Note: Lesser clearances may be considered if brining tanks or flumes are provided with CIP systems.

Floor Mounted Tanks or Flumes

When tanks or flumes are mounted directly on the floor, the following criteria apply:

1) The tanks must be firmly and completely bonded to the flooring materials so that water or other liquids cannot seep under the tank or flume.

2) The tank to floor juncture must have a curved cove molding with at least a 1 inch (25 mm) radius to facilitate cleaning of the juncture.

3) There must be no mounting brackets for pipelines, electrical connections, or other additions that breach the exterior integrity and would permit entrance of liquid into any interior void areas under the tank or flume.

4) The tank or flume system is mounted to permit access around the exterior for cleaning and inspection.

Additional Equipment & Accessories

1) *Construction* - baffles, gates, baskets, frames, racks, and other accessories must be mechanically sound, sufficiently strong for the intended use, and corrosion resistant. Parts must not be painted. Threaded and bolted construction, woven plastic or stainless steel screen material, and braided stainless steel cables that are not immersed in the brine are satisfactory and there are no minimum radii requirements under USDA requirements. *Note (input from NY & WI Regulatory)*: Equipment with threading and/or bolts or of woven or braided materials are not considered to be of sanitary design. If used in direct product contact, they require disassembly for manual and/or COP cleaning. Equipment of alternative sanitary, cleanable design should be used wherever possible.

2) *Utensils* - any special equipment or utensils employed in or around the brine tanks, including such items as tables for removing cheese from hoops, brine tank dividers, salt buckets, tools for moving the cheese, and other utensils must be constructed of stainless steel, plastic, or rubber materials that comply with 3-A Sanitary Standards and 3-A Principles should be followed in their fabrication. These items must be cleaned after each use and properly stored when not in use.

3) *Storage* - utensils and other equipment; and baskets, frames, or racks that are removed from the brine tank for cleaning and storage, or staging for loading, must not be stored on the floor. Sanitary storage racks, hangers or platforms must be provided. These items must be cleaned after use and properly stored when not in use.

4) *Guards* - any guards required by safety standards that prevent accessibility for cleaning and inspection must be designed to be self-draining and easily removable for cleaning and inspection.

5) *Conveyors* - conveyors that run partially submerged in chilled brine systems are not required to meet the sanitary construction requirements of product contact conveyors. Bent wire conveyors and plastic link conveyors that are not acceptable for use in other applications as exposed product conveyors may be acceptable for brine system discharge conveyors if they comply with the following:

a. The conveyor must be removed from the brine for cleaning as needed; they shall not be cleaned while immersed in brine tanks or flumes unless they have been drained and are to be cleaned.

b. The conveyors must be designed so that lubricated bearings, including sealed bearings, are not immersed in the brine.

6) *Walkways* - walkways over brine tanks must have a solid floor with a kick plate or guard a minimum of 4 inches high on the portion of the walkway over the tank so that debris cannot fall into the tanks.

BRINE PREPARATION, MAINTENANCE & QUALITY

Brine Preparation

1) *Salt* – cheese brine is a solution of sodium chloride (NaCl) salt in water, which may be a saturated solution, but typically ranges from 18-25% (weight/weight) depending on the cheese variety and methods used. Things to consider when preparing salt brines include:

a. Lower brine salt levels than appropriate for the cheese may cause quality defects, especially when less than 18%. Saturated brines are easier to make accurately and maintain than lower % salt brines, providing an easy standard against which future batches can be measured. As salt level increases in the brine however, salt uptake in the cheese will increase.

b. Using reverse osmosis water that has been pasteurized or treated with UV light has been recommended in preparing brines to reduce the risk of impurities (e.g., iron or sulfur water) and contaminants (e.g., microorganisms), especially when the water source is in question.

c. Brine strength should be checked when prepared with a refractometer, salometer or hydrometer; by titration; or by calculation. Ensure that the testing procedure used is appropriate for brine solutions as per consultation with the test system manufacturer/supplier. Methods used should be routinely checked against standard salt solutions.

d. There are a number of ways to calculate how much salt is needed to make a brine. The table below provides the amount of salt (NaCl) needed to make 0 to 26% (w/w) brine solutions per measure of water under standard conditions of 60°F (15.6°C). NaCl at 26.395% in water is considered fully saturated at 60°F; any additional salt will not dissolve at this temperature. Higher water temperatures will allow greater amounts of salt to dissolve.

Percent (%) Salt	Kilograms (kg) Salt Per Liter Water (1kg/L)	Pounds (lbs.) Salt Per US Gallon Water (8.34 lbs./gal)
0	0	0
2	0.0204	0.17
4	0.0417	0.347
6	0.0638	0.532
8	0.0870	0.724
10	0.1111	0.925
12	0.1364	1.136
14	0.1628	1.356
16	0.1905	1.586
18	0.2195	1.828
20	0.2500	2.082
22	0.2820	2.349
24	0.3158	2.630
26	0.3513	2.926

2) *Acid & Calcium* - new brine is typically acidified to a pH close to or below the pH of the cheese (e.g., ~ pH 5.0). This can be done using food grade acids (e.g., lactic, acetic, or citric). The final pH should be determined. Calcium chloride is also typically added to new brine to match the calcium content of the cheese to be brined (e.g. 0.3 - 0.5% w/w). This is added to establish an equilibrium that prevents leaching of calcium from the cheese, which can result in surface and rind defects.

3) *Temperature* - after making the brine, it needs to be cooled. Cheese brine is typically cooled to temperatures of 53.5 - 57.0°F (12 - 14°C), again depending on the cheese and application. Utilizing plate or tubular heat exchangers facilitates cooling, but other methods are employed (e.g., jacketed cooling; cold room brine tanks or tubs).

Brine Maintenance

The purpose of brining cheese is to add salt to the cheese by absorption. As salt is taken up by the cheese, the salt content of the brine will be reduced, thus it needs to be constantly replenished. The rate of salt loss from the brine will depend on several factors including the type, shape and size of the cheese being brined; the temperature of the cheese entering the brine; the desired salt level in the final cheese; the brine salt concentration, temperature and pH; and the overall throughput of the system.

For consistent salt absorption by the cheese, brine solutions should be checked and adjusted for:

1) *Salt concentration*, using a refractometer, salometer or hydrometer; by titration; or by calculation. Consult with the testing system supplier to ensure that the procedure used is appropriate for testing brine solutions. Methods used should be routinely checked against standard salt solutions.

2) *Brine pH*, using a calibrated pH meter. Add food grade acid as needed. Both pH and calcium content tend to reach equilibrium with the moisture phase of the cheese as the brine ages, but these should be routinely checked.

3) *Temperature*, using a calibrated thermometer. Typical range for brine temperature is 53.5 - 57.0°F (12 - 14°C). Brine systems should be set up with cooling (e.g., recirculated brine heat exchangers) or tanks should be placed in a controlled and monitored cooler (e.g., for small scale).

Solids Removal

Brine systems should have equipment and methods, suitable to the size of the brine tanks or system, for removal of solids (e.g., fines) and particulate matter that come from the cheese.

1) *Skimming* - manual skimming of the brine should be done every day it is used with a fine screen or pool skimmer that is cleaned after each use.

2) *Filters* - coarse filters placed in the brine circulation flow can be used to remove solids. Filters must be routinely inspected and cleaned.

3) *Fines savers* - a cheese fine saver can be used. The fine saver should be washed each day and the fines should be discarded.

4) *Brine straining systems* - automated brine straining systems have been developed and are available for removing particulate matter from cheese brine. Contact appropriate dairy equipment supply companies.

5) *Ultra-Filtration (UF) systems* - UF systems have been developed and are available for more efficient removal of suspended solids, fat and protein from the brine, and may be effective in reducing the microbial load. Contact appropriate dairy equipment supply companies.

Treatments to Reduce Microbial Load

Brine solutions are generally used for long periods of time. Over time, certain microorganisms, including salt tolerant bacteria, yeast and molds, may increase in the brine, creating quality (e.g., gas or surface growth) and/or food safety concerns. Areas in brine systems where fat and/or foam accumulates may be more likely to encourage accumulation and/or growth of microorganisms; these areas should be routinely cleaned and sanitized as appropriate. *Listeria monocytogenes* and other organisms of public health concern

have been found to survive in cheese brines, stressing the importance of proper sanitation and brine maintenance, treatment and protection to prevent brine contamination and the potential development of microbial biofilms.

Discard - Clean – Replace

Cheese companies are encouraged to test brines for microbial loads and based on results, periodically:

1) Completely empty all brine from the system and discard following local waste regulations;
    a. alternatively, brine can be treated (see below) and transferred to storage.
2) Thoroughly wash and sanitize the brine system and all components.
3) Prepare a fresh brine solution and check to ensure desired parameters of salt level, pH, calcium and temperature are met.

Treatment Options to Extend Brine Life

Brine replacement can be delayed by treatments that reduce microbial loads. The frequency of treatment will depend on the determined microbial load and the effectiveness of the selected systems. Treatments that have been applied include:

1) *Pasteurization* - the temperatures and hold times used for brine pasteurization are at the discretion of the plant. While there are no legal temperatures and holding times for pasteurizing brine, the legal requirement for milk can be used; e.g., at least 161°F (72°C) for at least 15 seconds.
    a. if pasteurization is used, check with the pasteurization equipment manufacturer for any concerns with corrosion and/or gasket deterioration when heating brine solutions. Alternative, non-corrosive materials may be warranted (e.g., titanium).
2) *Ultraviolet (UV) light* - UV systems are available for the treatment of brine, but efficacy is dependent on the level of solids in the brine and the UV light penetration range. UV systems generally should be used only after a filtration step that removes the bulk of the solids (e.g., Ultra-Filtration).
3) *Microfiltration* / *Ultrafiltration* - filtration systems have been designed and are available specifically for treating cheese brine. Contact appropriate dairy equipment supply companies.

Alternative methods that have been investigated and/or are commercially available include oxidizing agents such as ozone or chlorine dioxide, but these may have reduced effectiveness in solutions with elevated protein or solids levels found in used brines. Other oxidizing agents such as peroxyacetic acid and hydrogen peroxide are influenced less by solids, but the influence on cheese flavor needs to be determined.

Cheese makers are encouraged to research available procedures and processes available to treat and reduce microbial loads in brine and work with suppliers to make sure systems are optimized and validated.

General considerations in brine treatments include:

- The design and application of the system should be such that brine treated for microbial reduction is not mixed with untreated brine.
- Treatments should allow for cleaning of brine tanks and associated equipment (e.g., clean storage of treated brine during cleaning)
- After treatment, brine salt level, calcium level, pH and temperature should be checked and adjusted accordingly.

Automated Systems

Complete brine handling systems consisting of brine storage; salt storage, testing and dosing systems; microfiltration or other alternatives for brine cleaning and treatment; plate heat exchanger for temperature control; and/or other automated controls are available from a number of suppliers. These systems are desirable for larger cheese manufactures with large brine systems and needs. Contact appropriate dairy equipment supply companies (see examples in reference section).

OTHER BRINE SYSTEM AND USE CONSIDERATIONS

Cheeses Made from Raw and Pasteurized Milk - Separate Brine Systems

Plants that make cheese from both raw and pasteurized milk must have procedures in place that prevent cross-contamination of the processes and products at all stages. This is in line with the intent of 21 CFR 117, *Good Manufacturing Practices, Hazard Analysis and Risk-Based Preventive Controls for Human Food* under FDA. Using the same brine solution for raw and pasteurized cheese would create a potential cross-contamination event.

- **Best practices for cheese plants that manufacture cheese made from both raw and pasteurized milk would be to have separate production lines and areas, including separate brining systems, which would be required to prevent cross-contamination**.

Currently, there are no USDA regulations that specifically address brine use for cheese made from raw and pasteurized milk. State Regulatory agencies that provided comments for this indicated that using the same brine for cheese made from raw and pasteurized milk would be an unacceptable practice and not allowed. Cheese manufactures should consult with their governing regulatory agency on specific policies that address this (see WI perspective below).

Note (input from WI Regulatory): Under *WI Regulation ATCP 65.40* there cannot be any cross contact between raw and pasteurized product unless there is some process or procedure in place that would eliminate the risk. If a company felt a need to use the same brining system for cheeses made from both raw and pasteurized milk, they would need to provide documentation to substantiate the safety of the process before being permitted to do so. This should include written procedures with appropriate records and safeguards that have been validated to eliminate the risk for cross-contamination and that meet the regulatory agencies approval. Generally, the practice is discouraged.

Handling Cheese in Brine

1) Since cheese will normally float in a saturated salt solution, it should be turned or have extra salt added to the top to ensure uniform salt absorption. The brine circulation system can also be used to continuously spray brine on the top of the cheese. This is not a concern in rack systems that fully submerge the cheese in the brine.
2) The brine system must be operated to ensure the brine is clean, well circulated to ensure uniformity, and of the proper strength and temperature for the variety of cheese being made.
3) In very small cheese operations, brining tanks or vats may be located in a cooler room for temperature control. However, without circulation, brine strength tends to stratify as salt is absorbed into the cheese from the top of the tank. Periodic mixing may be needed.
4) When the brine tanks are located in a separate processing room, cooling of the brine may be necessary. The preferred method is for recirculation of the brine through a filter or membrane system, a cooler (plate or tubular type, for instance), and back to the tank. The filter or membrane system removes impurities, the circulation prevents stratification of brine strength in the tank, and the cooler removes heat imparted by the cheese. It should be designed to remove brine from one end and put it back in the other end to help the circulation of the brine.
5) Cooling of brine with refrigerated copper coils immersed in the brine tank is a questionable practice. Excessive copper salts may be in solution in the brine and be absorbed by the cheese. Therefore, copper coils are unsatisfactory and must be replaced with stainless steel.
6) If you are aging cheese in brines you should always handle the oldest first, then to the newest.

Cheese Drying After Brining

The facilities for drying cheese after brine immersion must be constructed to protect the cheese from contamination. Product contact surfaces of such equipment must be made of stainless steel, plastic, or other materials that comply with the 3-A Sanitary Standards. If a drying tunnel is used, the interior surfaces must be free from peeling paint or rust; because of the brine, stainless steel construction is desirable, although not required.

RESOURCES

Note: References, addresses and internet links change with time. The reference provided below were current at the time this document was prepared. The reader should check for current and other applicable references.

USDA - System Review Service & References

Reviews of brine systems are available from the Dairy Grading Branch of the U.S. Department of Agriculture (USDA). A fee is charged for this service. It is recommended that the purchase contract or order specify that the equipment is to meet an appropriate standard. Contact information for this service is:

USDA - AMS - Dairy Program
Stop 0225, Room 2968 – South
1400 Independence Avenue, SW
Washington, D.C. 20250-0225

Phone: 202-720-4392
Email: DairySanitaryCerts@ams.usda.gov

USDA. 2001. USDA Guidelines for the Sanitary Design and Fabrication of Dairy Processing Equipment. Available at: https://www.ams.usda.gov/services/auditing/dairy-plant-survey-program (accessed 06-10-19)

USDA. 2012. General Specifications for Dairy Plants Approved for USDA Inspection and Grading Service. Available at: https://www.ams.usda.gov/services/auditing/dairy-plant-survey-program (accessed 06-10-19)

Code of Federal Regulations (CFR)

CFR References are *available on line at* (accessed 06-10-19, check for updates):
https://www.ecfr.gov/cgi-bin/ECFR?page=browse

Cited References from Title 21 - FOOD AND DRUGS:

§170.39 Threshold of regulation for substances used in food-contact articles.
https://www.ecfr.gov/cgi-bin/text-idx?SID=315432f38428f8e4f8e8d882ac1c80f8&mc=true&node=se21.3.170_139&rgn=div8

PART 174 - INDIRECT FOOD ADDITIVES: GENERAL

§174.5 General provisions applicable to indirect food additives.

§174.6 Threshold of regulation for substances used in food-contact articles.
https://www.ecfr.gov/cgi-bin/text-idx?SID=315432f38428f8e4f8e8d882ac1c80f8&mc=true&node=pt21.3.174&rgn=div5

PART 177 - INDIRECT FOOD ADDITIVES: POLYMERS
https://www.ecfr.gov/cgi-bin/text-idx?SID=e6015f77ceeb5e5d5a5ff0f35b66e006&mc=true&node=pt21.3.177&rgn=div5

Other Resources

Guinee, T.P. 2007. How should cheese brine be prepared and maintained? In *Cheese Problems Solved*. P.L.H. McSweeney, ed. Woodhead Publishing.

Johnson, M. and K. Paulus. 2005. Salting your cheese - how to get it right. Wisconsin Center for Dairy Research. Dairy Pipeline Vol 17, no. 1.

Hoffman, Mary K. Control of Listeria monocytogenes in Cheese Brines: A Literature Review. Masters Major Project/Report submitted to the faculty of the Virginia Polytechnic Institute and State University.

Tetra Pak Processing Systems. 2015. Dairy Processing Handbook.

Supplier Web Sites (accessed 06-10-19, check for updates)

Note: The following company websites were found to have useful information on brine systems. The DPC does not endorse one company over another. The reader should do additional searches for appropriate suppliers.

GEA, MF Brine System:
https://www.gea.com/en/products/coldsan-cold-sanitation-cheese-brine.jsp

Johnson Industries International, Brine Systems:
http://www.johnsonindint.com/cheesemaking/brining/

Pall Food & Beverage, Brine White Paper:
https://food-beverage.pall.com/content/dam/pall/food-beverage/literature-library/non-gated/FBTBCBEN.pdf

SPXFlow/APV, Brine Systems:
https://www.spxflow.com/en/apv/pd-mp-cheese-brine/
https://www.spxflow.com/en/assets/pdf/APV_Cheese_Technology_6003_03_02_2013_GB.pdf