Cleaning and Disinfection in a Dairy Industry

Dairy Plants Cleaning and Disinfection Technology

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Formation of Milk Deposits

- **Fouling** is the deposition of material resulting from chemical reaction, or crystallization on the heated surfaces of milk processing equipment.
- Fouling results in the build up of a layer of deposits on the equipment surface

Results of fouling

- ✓Prevents efficient heat transfer in pasteuriser/steriliser. Heat transfer efficiency is reduced
- **Result - running costs increase**
- **Deposit acts as a reservoir for microorganisms**
- **Result - dirty equipment contaminates milk**

Results of fouling

- **Deposit narrows the gap between heat exchanger plates, causing pressure increase on product side**
- **Result - rate of processing slows resulting in short running times.**
- **Must stop processing for intermediate cleaning to remove deposits**

The Fouling Process

- **Below 110°C, deposit is 50-60% protein, 30-35% minerals**
- **50% of the protein is β-lactoglobulin**
- **β-lactoglobulin is only 10% of total raw milk protein**
- **At 70°C β-lactoglobulin denaturates and forms insoluble protein aggregates.**
- **Aggregates lead to formation of fouling deposits**

Two stage fouling

- First stage - slow build up of salts and proteins deposited on equipment surface
- Second stage - rapid fouling
- Rate and quantity is a function of pasteurisation temperature, holding time and preheat milk treatment
- The higher the pasteurisation temperature, the higher the mineral content the lower the protein content

Deposit classification

- Low temperature pasteurisation, ≤80°C - soft deposit
- **High temperature pasteurisation, 85 °C - tough, hard deposit**
- Milk fat is in the protein deposit layer
- **Two layers - mineral salts layer, smooth compact, thin: protein layer, fibrous, spongy, porous**

Principles of Cleaning

- **Clean everything that has been in contact with milk**
- **Use correct chemicals, detergents**
- **Use correct concentration**
- **Use correct temperature**
- **Use correct contact time**
- **If equipment is not cleaned properly then products will be contaminated and spoil quickly**

What to improve in our system?

What is the experiences in Etete Milk ❑

Processing❑

Let us plan to check and solve this **Fouling**✓

Are we making **confirmation tests**✓

Need support from management .✓

Where to start✓

Production, Quality control and consultants ✓ need to **draw Action plans** via assessment with action of mitigation mechanisms

ready for change of modalities via fast investment ✓

Improve our learning and understanding curves

Start from utility sections to chemicals and efficacy of cleaning process as a whole ✓

Prepare cleaning and disinfection protocol in dairy industry ✓

Assign personnel for this purpose ✓

Avoid traditional practices and do in more proper way for successes of the plant ✓

Learn from other dairy industries ✓

Organize a team and practices it intensively as fast as possible (No time…) ✓

Design solutions and practice it

N.B! It is a must to do work

Clean equipment is not enough

- **Clean buildings, walls, floors, drains, toilets, workers clothes, personal hygiene**

- **Dirty environment = contaminated products**

Buildings

- Must be clean at all times
- Tiled walls easy to wash and clean
- Floors free draining, resistant to alkali and acid
- Protect building against rodents, insects and birds
- **Position processing equipment so that it is accessible from all sides for cleaning and maintenance**

Services and Personnel

- **Water - good bacteriological quality**. If not good then treat with **sodium hypochlorite 2 ppm 2 mg/litre**
- **Clean steam - filter before use**
- Good lighting to illuminate working areas
- **Workers must maintain high standards of hygiene in processing departments**

Cleaning - The Three Steps

- **Pre-rinse - removes easily rinsed residues from equipment surfaces. Water**
- **Cleaning - removes all adhering deposits from equipment surfaces. Alkali and acid**
- **Final rinse - wash off all chemical residues from equipment surfaces. Clean water**

Types of cleaning

- **Two stage cleaning - sodium hydroxide, nitric acid**
- Alkali removes protein and fat
- Acid removes mineral salts
- **One stage cleaning** - commercial **'smart'** detergents that contain surface-active agents, emulsifier, chelating agents

Factors affecting cleaning efficiency

- **Points of contact** between heat exchanger plates - poor penetrability
- **Non-porous deposits** produced by high temperatures resist chemical penetration
- **Geometry and design of equipment**
- **Cleaning is an expensive operation and must be optimized for maximum efficiency**

Procedures to reduce fouling

- There is no simple solution to reducing the degree of fouling
- Refrigerated storage for 24 hours before heat treatment reduces fouling
- Chemical changes to the milk can change the degree of fouling. This is not permitted in most milk products
- Maintaining turbulent flow reduces fouling
- Reduce temperature differential between product and heating medium. Requires larger heat exchanger surface
- These are all design solutions - not practical in dairy

Advantages of CIP

- Reduced manual work
- Elimination of human error
- **Industrial safety**
- Improved cleaning
- **Improved product bacteriological quality**

Control of a CIP process

- **Microbiological monitoring of the plant equipment - coliform tests, line tests**
- **Are we practcing this? P/QC??**
- **If not whose mistakes is it and How to improve these Gaps?**
- **Choice of correct chemicals for the job**
- **Temperature**
- **Time and Concentration**
- **Pressure/Flow rate - 1.5 meters/second**

Temperature

- **Caustic soda - 65-70°C** is the optimum temperature for maximum soil removal
- If temperature is too low then the time required will be very long
- **Monitor temperature on the return line at the nearest point to the circulating tank**

Time

- The required time must take into account the length of the pipeline and so the time required for the solution to reach its target
- In an optimally designed system, **the time required to remove deposits is about 20 minutes**
- **In non-optimally designed systems, the time must be adjusted**
- **Let us start our Assignments to do all these for better quality and profitability.**

Concentration

- The cleaning process can only be effective if the correct concentration is used
- Rinse water must not be allowed to dilute chemical concentration
- **Monitor concentration frequently**

(Are we practicing this @ Etete Dairy?)

- **Caustic soda - 2%**
- **Nitric acid - 1%**

Pressure or velocity

- **Turbulent flow is the most effective - it has a mechanical effect that helps remove deposits**
- **Optimum flow rate - 1.5 meters/second**
- **Monitor the pressure after the supply pump**

The three sequential steps in processing milk

- Raw milk storage
- Heat treatment
- Packaging
- These are connected by pipeline systems
- From the point of view of cleaning, the three stages are separate from each other and each requires specific treatment

Pipeline Systems

- **Raw milk and pasteurized milk lines must NEVER be interconnected**.
- **How is our practices @ Etete??**
- **Think for dynamic change**
- **Cross connection is potentially dangerous** because of the risk of contamination by pathogens from raw to pasteurised
- **Do not mix pipelines of different diameters** as it will change the flow velocity in different sections of the circuit.

Pipeline design

- **Flow velocity 1.5 meters/second**
- **Welded joints -** orbital argon arc welds
- **At certain points in circuit, connections to heat exchanger, filling machines, must use screw-type fittings**.
- These must be dismantled, hand cleaned, gaskets changed
- **Pipelines must be free draining, minimum slope of 1 in 150. No dead ends**

Storage tanks

- Pasteurised product tanks - clean after every use
- Raw milk tanks - clean once every 24 hours
- Low pressure/high volume system - static plate distributor, floods tank walls - large capacity silos
- High pressure/low volume - sprayball
- Vent tanks to prevent vacuum collapse

Product Safety !!!!...

- **Must have safeguards to prevent CIP solutions entering a tank of product or product entering a tank being cleaned**
- **Spray balls must be inspected daily for correct operation**
- **The final rinse must be sufficiently long** and effective **to ensure that all chemical residues are removed (Very critical)**

Heat exchangers

- The most difficult item of equipment to clean. Closed system, cannot be inspected visually
- **Factors affecting type and quantity of deposit - physico-chemical stability of raw milk, treatment temperature, temperature differentials, length of processing run**
- **Before cleaning, open flow control valve and back pressure valve to maximum - increases flow rate**

Filling machines

- Every filling machine requires special considerations: construction metal, piping complexity, geometry, valves, hopper tanks
- Consider hand cleaning or COP (Cleaning On Place). **Choice of detergent/chemicals - safety, effectiveness**
- COP is sometimes more effective when flow is in reverse direction to the normal milk flow

Plant sterilization

- Sterilisation is the destruction of microorganisms
- Sterilisation can be by heat or by chemicals
- Each chemical has its own spectrum of activity against species and types of organisms depending on application time, pH, concentration, application temperature
- Choice of chemical must take into account the materials of construction

There are two types of microorganism destruction

- Disinfection - destruction of vegetative bacteria, yeasts and moulds
- Sterilisation - destruction of spores
- Surfaces to be sanitised must first be effectively cleaned
- Use chemical sterilants for pipelines and product storage tanks. Unheated solutions at relatively high concentration followed by slightly above threshold concentrations for overnight standing

When to sanitise

- Can be after cleaning at end of day, or immediately before startup the following day.
- Possible to do both, particularly with sensitive products.
- **Two-stage sanitizing, is an excellent system**.
- **Chemical sanitizing after cleaning at end of day and hot water sanitizing before startup the following day**.
- **What is the current practice @ Etete?**

Possible sanitizing programmes

- **Chlorine rinse solution after cleaning, possibly with overnight contact, followed by hot water the next day before startup**
- Because of overnight standing, chlorine level must be low, 2-3 ppm. Hot water removes the sterilant and is convenient while warming up the heat exchanger

Possible sterilants

- Iodophores, **sodium hypochlorite**, quaternary ammonium compounds, **peracetic acid**, hot water
- **Once a week, use hot water only because some organisms are inherently resistant to chemical sterilants and these must be destroyed to prevent build up in the equipment**

Working solutions

- **Use the manufacturer's recommended concentrations, contact time and temperature**
- **Allow pipelines to drain and dry overnight**
- **Sodium hypochlorite at high concentration is corrosive to stainless steel**

Cleaning agents

- Each cleaning task has specific requirements, so **choice of chemical is critical to success**
- Must be able to detach soils from surface and keep them suspended as fine particles in the cleaning solution
- **Must prevent deposit of milk stone, water scale and soaps**

Cleaning agents

- Must be surface active so that surfaces are wetted easily so that soils and cleaning agents are easily rinsed off
- Must not attack metals and other construction materials
- Must be stable and have good storage qualities
- **Must be officially approved for use in dairies**
- **Must be able to monitor concentration at purchase and in use**

Types of cleaning agents

- Alkalis
- Acids
- Softeners
- Emulsifiers and wetting agents

Alkalis

- **Alkalis dissolve protein and saponify fats**
- **Caustic soda (NaOH) can be purchased as flakes (100% NaOH) or as solution (46-48% NaOH)**
- Difficult to rinse off surfaces, corrodes aluminium, tin, zinc and glass
- When used in hard water deposits calcium carbonate

Acids

- **Nitric acid (HNO_3) removes mineral salts**
- Effective on stainless steel and aluminium
- **Has disinfecting action**
- **Purchased as 63% solution**
- **Phosphoric acid (H_3PO_4) is less corrosive than nitric acid**

Softeners

- **Hard water causes deposit of calcium and magnesium precipitates on equipment surfaces**
- **Prevent precipitates by using soft water**
- Soften water by treating all water in an ion exchanger or add softener
- **Polyphosphates used as softeners, also EDTA**

The Basic Cleaning Process

- Successful cleaning depends upon a number of factors
- Choose correct chemical agent
- Concentration
- Temperature
- Time

The basic cycle:NB!

- Pre-rinse water - cold water, can use final rinse water from previous cycle
- **Caustic soda, 2%, 65-75°C, 20 minutes**
- **Intermediate water rinse - cold water**
- **Nitric acid, 1%, 55 °C, 20 minutes**
- **Final rinse, bacteriologically clean water**
- **Sanitise with hypochlorite, 20ppm, cold**
- **Hot water, 85-90 °C, before startup**

Methods of Sanitization

Chemical: Must be used according to the manufacturer's instructions to be effective

Steam:

When steam is used, each group of assembled piping shall be treated separately by inserting the steam hose into the inlet and maintaining steam flow from the outlet for at least 5 minutes after the temperature of the drainage at the outlet has reached 94°C. The period of exposure required here is longer than that required for individual cans, because of the heat lost through the large surface exposed to the air. Covers must be in place during treatment

Hot Water:

Hot water may be used by pumping it through the inlet, if the temperature at the outlet end of the assembly is maintained to at least 77°C for at least 5 minutes

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Cleaning

The basic steps of cleaning plant and equipment

- Rinsing with water to remove gross soil.
- Cold or tepid water (30-40°C) is optimal. Temperatures up to 85°C may be used for equipment that has been in contact with butter.
- A cleaning treatment with detergent solution at an appropriate temperature so that the soiled surface is free from soil.

Pasteurizer and Pipelines

- When treatment of the milk is finished the pasteurizer, pipes, valves should be thoroughly flushed with water
- **Add 300 – 500 gm of sodium hydroxide per 100 litres of water in the system**
- **Circulate at 75C for 20-30 minutes**
- Flush with water until all sodium hydroxide solution has been washed out
- **Add 0.5 – 1.0 litre of nitric acid (62%) per 100 litres of water**
- **Circulate at 60C for 20-30 minutes**
- **Flush with water until all nitric acid solution has been washed out**

If the water is very hard, 300 gm trisodium phosphate per 100 litres should be added to the solution

Notes

- Cleaning chemicals in powder or solid form should first be dissolved in water before adding to the system
- **If the plant is very dirty then increase the concentration of the chemicals and double the circulation time**

In the Morning….

- Before starting to process milk you MUST sterilize the plant
- Circulate clean water through the plant and heat to 80-90C
- Allow water to circulate at this temperature for at least 10 minutes
- Do not use chlorine for sterilizing
- For pipes that are not part of the circuit you must allow the hot cleaning solutions to flush through the pipes. Also use steam hosing and examine the condition of the pipes every day

Butter Churns

- **Wash with hot water at 95C**
- **Can add 0.2% trisodium phosphate to the water**
- **Rinse**
- **Wash with more hot water at 95C**
- **The volume of water used should be equal to 10% of the total churn capacity**
- **Churn the water at maximum speed for not less than 5 minutes**

Milk Cans and Churns

- Use caustic hot caustic soda solution for every daily cleaning
- Weekly also clean with hot dilute solution of nitric acid
- Sterilize with boiling water

Cloths

- **Cloths can be one of the top causes of cross-contamination**

- **It is essential to use them safely to prevent bacteria from spreading**

Rules for Cloths

- Use single-use cloths wherever possible and throw them away after each task
- Always use a new or freshly cleaned cloth to wipe work surfaces, equipment or utensils that will be used with ready-to-eat food

This will make sure that any bacteria picked up by the cloth will not be spread.

- It is especially important to protect ready-to-eat food from bacteria. This is because the food will not be cooked so any bacteria on the food will not be killed

Cloths in the Dairy

- If using re-usable cloths, make sure they are thoroughly washed, disinfected and dried between tasks (not just when they look dirty).
- Ideally, wash cloths in a washing machine on a hot cycle.
- If you wash and disinfect cloths by hand, make sure all the food and dirt has been removed before you disinfect them
- Use hot water to disinfect the cloths
- **Using dirty cloths can spread bacteria very easily**
- A hot wash cycle will clean the cloths thoroughly and kill bacteria (disinfect).
- **If food or dirt is still on the cloths, this will l prevent the disinfection process from being effective, so harmful bacteria might not be killed.**
- **Not allowed to have food and drinks in dairy industry**

Managing the Use of Cloths

- If you notice dirty cloths being used, remove them for cleaning immediately or throw them away.
- If you think your staff have used a dirty cloth, wash, disinfect and dry any equipment, work surfaces or utensils it has touched.
- Consider using single-use cloths if you are not using them already
- Increase your supply of single-use/clean cloths
- Train staff again on this safe method
- Improve supervision

Packaging

- **Packaging materials should be stored and used in a clean and sanitary manner**.
- Packaging materials should be non-toxic and should not leave harmful or undesirable deposits on the product or otherwise contaminate it.
- Packaging should be carried out under conditions that avoid contamination of the product, and should provide adequate protection of the product against contamination until the product reaches the consumer

Storage of Finished Products

- **Products should be stored in clean conditions at the appropriate temperature and humidity to prevent deterioration, or under such conditions as may be required for maturation.**
- Products should be protected against contamination while in storage

Transport

- Products should be transported in clean vehicles under clean conditions.
- Short shelf life products should be transported in insulated and preferably refrigerated vehicles at temperatures between 0°C and 6°C.
- **Dairy products should not be transported with other goods in a way, which may adversely affect the quality of the product**
- Tankers used for the transport of milk and milk products should not be used for the transport of other products.
- **The internal surface of vehicle bodies should be smooth, impervious and easy to clean and disinfect.**
- **Vehicle bodies should be sealed so as to prevent the entry of pests and other sources of contamination.**

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Hygiene and Health

- It is recommended that persons engaged in the handling of food should be subjected to relevant **health checks on starting employment**, and at **appropriate intervals** depending on epidemiological considerations, the nature of the food materials being handled and the previous medical history of the person

Infectious Diseases

- **Any persons known to be carrying an infectious disease** or any persons suffering from an infectious disease or in contact with anyone having an infectious disease, or while afflicted with infected wounds or sores, or diarrhoea should be required to report immediately to the management.
- Such persons should not be permitted to work in any food handling area in any capacity where there is a likelihood of them directly or indirectly contaminating food.

Injuries

- Cuts or sores should be completely protected with waterproof dressings, firmly secured and conspicuous in colour, and the person should not be allowed to carry out work, which could result in the contamination of food.

Personal Hygiene

- **Personnel should be instructed** in the principles of hygiene and should be required to maintain a **high degree of personal cleanliness and hygiene**.

- **Smoking, eating, chewing or unhygienic practices such as spitting should be prohibited in food handling areas**

Hand Washing

- Hands should be washed before commencing work, and immediately after handling contaminating material or using the toilets.
- After handling material, which might be capable of transmitting disease, hands should be sanitized as well as washed

Protective Clothing

- **Clean protective clothing, including head covering and where appropriate suitable gloves and footwear should be worn.**
- **It is recommended that protective clothing should be without pockets and without buttons.**
- Clothing should be washable or disposable and maintained in a clean condition, consistent with the nature of the work.
- To avoid the risk of contamination from the inside of gloves, products should not be directly handled after removal of gloves without previously washing, drying and sanitizing the hands.
- **Personal effects, jewelry and street clothing should be stored in the changing rooms**

Visitors

- **Visitors should be required to observe the relevant requirements in relation to hygiene**.
- In particular, precautions should be taken to prevent visitors entering food handling areas and from becoming sources of contamination.
- Visitors should be required to wear protective clothing and protective footwear.
- **Separate toilets should be available for visitors**.

Domestic Animals

- **Dogs, cats and other domestic animals should be excluded from the establishment**

Laboratory Controls

- Milk and other raw materials should be subjected as required to appropriate and regular hygienic quality examination and should be of acceptable quality for processing.
- Final products, and intermediate products at various stages of manufacture, should be subjected to appropriate and regular microbiological examination and remedial action taken in the way of cleaning and sanitizing when there are indications of adverse trends in the microbiological results.

Pest Control

- Good housekeeping and the avoidance and removal of nests are important in avoiding infestation.
- An effective and continuous programme for the control of insects, birds, rodents or other vermin within the establishment should be maintained.
- Establishments and surrounding areas should be regularly examined by suitably trained personnel for evidence of infestation by insects, birds, rodents and other vermin.
- In the event of infestation, appropriate measures should be taken to remove the source, with due care as to proper and safe use of chemical, physical and biological agents, which may be used.
- Pesticides should only be used if other methods are neither appropriate nor effective. All foods and work areas must be protected before use of pesticides. After application, all areas must be cleaned thoroughly and sanitized prior to use.

Sanitation Control Programme

- **The specific responsibilities of staff in relation to cleaning and sanitizing should be clearly defined.**
- **Staff should be trained in the use of chemicals, cleaning compounds, special cleaning tools, methods of dismantling equipment for cleaning and should be instructed in the significance of contamination and the hazards involved.**
- A permanent cleaning and sanitizing schedule should be drawn up to ensure that all parts of the establishment are cleaned appropriately and that critical areas, equipment and materials are designated for specific cleaning and/or sanitizing at defined intervals.
- **A single member of the staff** should be responsible to the management for cleaning and sanitation, and should have a thorough understanding of the significance of contamination and the hazards involved.

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Thank you


Strawberry Milk
LAND O LAKES
GOOD to GO!
Strawberry Milk
16 FL OZ (1 PINT) 473 mL
Vienna Roast
LAND O LAKES
Grip'n GO
Grippaccino
Vienna Roast
COFFEE FLAVORED LOWFAT MILK
VITAMIN A & D
ULTRA PASTEURIZED
12 FL OZ (355mL)
parmalat
milk
MAHEU
PINEAPPLE FLAVOUR
Bonnita
Gabana
TROPICAL
SWEETENED DAIRY FRUIT BLEND