# Chlorine-free cleaning of milking equipment to avoid residues and achieve low bacterial counts in bulk tank milk

**Dr David Gleeson**

*Livestock Systems Department,*

*Teagasc Moorepark*

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# Chlorine-FREE cleaning

- **Chlorine was very effective product against protein deposits, thermoduric bacteria-was effective if used with cold water**
- **The use of chlorine masked a lot of poor cleaning practises**
- **First country to adopt new chlorine-free cleaning of milking equipment**
- **Robotic systems use chlorine-free protocols**
  - **- high temperatures and higher concentrations of caustic**
- **Removal of chlorine is compensated by key changes to existing wash protocols- individual or combinations of changes**
    - **Not just a case of changing drums**

# Soils that might occur in milking machines include

- **Organic residues (from milk)**

  - Lipids (fats), proteins, carbohydrates (sugars)- Detergent

    -(sodium hydroxide/caustic)

- **Mineral deposits (mainly from water)**

  - Calcium, magnesium, iron, others- Acid
  (phosphoric/nitric) (Peracetic acid)

- **Bacterial films**

  - Bacteria can form bio-films on organic substrates if allowed to incubate

# Chlorine-free cleaning- What is required

- **Removal of chlorine is partially compensated by:**

  - **Higher caustic concentrations required**
    - **0.7% hot water & 1% cold water**
  - **Hot water is vital —75/80ºC: 7 hot washes minimum**
  - **Less hot washes required when using powder- 76 v 20 % Finish temperature ideally >45/50ºC**
  - **Increased use of 'existing' acid based products phosphoric/ nitric**
    - **2 descale washes per week (minimium) Or use new 'ONE for ALL' acid based products**
  - **Peracetic acid in an additional final rinse**
  - ***Chlorine-free cleaning Protocols:***
    - ***5 chlorine-free milking equipment cleaning protocols***
    - ***& 5 chlorine-free bulk tank cleaning protocols***

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# Chlorine-FREE cleaning –caustic products

- **Liquid caustic products ( sodium hydroxide) have much lower caustic content ( 20%) than powder (80%)**
  - **-compensate with increased temperature**
- **Recycling of liquid products no longer recommended**
- **Higher detergent usage rates are required when using cold water- up to 50% read the drums (always the case)**
  - **Example 100 litres water ( detergent; hot 700 mls: cold 1 litre)**
- **Caustic concentrations/ viscosity higher in new CF products as compared to detergent/sterilizer products**
- **– critical to recalibrate equipment**

# Chlorine-free cleaning-Hot water usage

- Adequate hot water is vital-9 litres/unit
- 7 hot washes per week-minimum
  - » Less hot washes (3) when using powder
- Water temperature- check in the wash trough
  - Start of cycle -75/80$^{o}$C : End of cycle -45/55$^{o}$C

# Maintaining the detergent wash cycle temperature

- Plate cooler water could be used for the post milking rinse
- Warm post-milking rinse-20/30$^{o}$C
- Option to send to dump first 10/20 l of water from hot cycle
- Circulation times for detergent cycle too long-8 to 10 min -max
- Fast fill
- Insulated trough/lid
- Drainage of post milking rinse vital

# Water Heating Running Costs

| System type | Cost per 100 litres hot water | $CO_2$ emissions per 100 litres |
|---|---|---|
| Day rate electricity | €3.08 | 3.2 kg |
| Night rate electricity | €1.54 | 3.2 kg |
| Gas (LPG) fired | €1.17 | 2.4 kg |
| Oil (Kerosene) fired | €1.35 | 3 kg |

•Convenience also affects decision making around system choice - Prices correct on 27/09/2022

## Chlorine-free cleaning-Use of **Acid** products

- 2 to 12 acid washes per week –depends on the protocol (e.g. 2 acid washes if 14 hot or 3 acid if 7 hot washes)
- Descale acid products-contain phosphoric/nitric acid-same as used for traditional wash protocols
- 'ONE for ALL' acid based products – descale/clean/disinfect-more likely for bulk milk tank
- Water hardness critical- water softener or more acid washes
- Peracetic acid-only alternative to chlorine

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# *Peracetic acid-alternative to chlorine contains: acetic acid, hydrogen peroxide, peracetic acid*

- *Peracetic acid breaks down in food to safe and environmentally friendly residues*
- *Can be used for the disinfection of clusters between individual cows*
- *The use of peracetic acid in the final rinse water is beneficial where there is an issue with the microbial quality of the water supply*
- *When used at the rates recommended, further rinsing with water to remove stains is not considered necessary –complete one hour before milking!*
- *Peracetic acid very effective against Thermoduric bacteria*
- *Low usage rates e.g. 60 mls per 45litres*

# OPTION 1: Chlorine free cleaning based on powder detergent (sodium hydroxide) and peracetic acid in an additional rinse

**After each AM milking**

1. Wash outside of clusters and jetters. Attach jetters to clusters
2. Remove or replace the milk filter sock
3. Rinse plant with 14 litres (3 gals) of warm or cold water per unit
4. Add an approved *powder detergent **(sodium hydroxide)** at the recommended use rate **in cold water or hot water at 70-80°C (minimum 3 hot washes per week)**, allowing about 9 litres (2 gals) of solution per unit
   - Circulate the wash solution for 8-10 min, having allowed the first 5 litres to run to waste. Can retain for the PM wash occasion.
5. Rinse the plant with a minimum of 14 litres (3 gals) of water per unit immediately after the wash cycle or prior to the next milking
6. Add peracetic acid at recommended rates in an additional cold water rinse

**After each PM milking**

1. Wash outside of clusters and jetters. Attach jetters to clusters
2. Remove or replace the milk filter sock
3. Rinse plant with 14 litres (3 gals) of warm or cold water per unit
4. Re-use the detergent wash solution retained from AM milking.
   - Circulate the solution for 8-10 min
5. Rinse the plant with a minimum of 14 litres (3 gals) of water per unit
6. Add peracetic acid at recommended rates to an additional cold water rinse

Replace the *powder detergent with an **acid** product on at least one occasion per week and more regularly if peracetic acid is not used twice daily

# OPTION 2: Chlorine-free cleaning based on liquid detergent (AM) and an Acid (PM) (Sodium hydroxide/phosphoric acid)

**After each AM milking**

1. Wash jetters and outside of clusters and remove or replace the milk filter
2. Rinse the plant with 14litres (3 gals) of warm or cold water per unit
3. Add an approved **liquid detergent** (sodium hydroxide) at the recommended rate in hot water (70-80°C), allowing about 9 litres (2 gals) of solution per unit
   - *Circulate the wash solution for 8-10min,having allowed the first 5 litres to run to waste*
4. Rinse the plant with a minimum of 14 litres (3 gals) of water per unit immediately after the wash cycle

**After each PM milking**

1. Wash jetters and outside of clusters and remove or replace the milk filter
2. Rinse the plant with 14litres ( 3 gals) of warm or cold water per unit
3. Add an approved **Acid cleaning product (phosphoric acid/ all in one products)** at the recommended rate in cold or hot water (70-80°C), allowing about 9 litres (2 gals) of solution per unit
   - *Circulate the wash solution for 8-10 min,having allowed the first 5 litres to run to waste*
4. Rinse the plant with a minimum of 14 litres (3 gals) of water per unit immediately after the wash cycle

# OPTION 3: Chlorine free cleaning based on liquid detergent (sodium hydroxide) and an acid (phosphoric/nitric)

**After each AM milking**

1. Wash outside of clusters and jetters. Attach jetters to clusters
2. Remove or replace the milk filter sock
3. Rinse plant with 14 litres (3 gals) of warm or cold water per unit
4. Add an approved liquid detergent (sodium hydroxide) **on 4 occasions per week** and an acid product on **3 separate occasions per week** (Monday, Wednesday, Friday) at the recommended use rate **in hot water** at 70-80°C, allowing about 9 litres (2 gals) of solution per unit
   - Circulate the solution for 8-10 min, having allowed the first 5 litres to run to waste
5. Rinse the plant with a minimum of 14 litres (3 gals) of water per unit immediately after the wash cycle

**After each PM milking**

1. Wash outside of clusters and jetters. Attach jetters to clusters
2. Remove or replace the milk filter sock
3. Rinse plant with 14 litres (3 gals) of warm or cold water per unit
4. Add an approved liquid detergent (sodium hydroxide) at the recommended use rate **in cold water**, allowing about 9 litres (2 gals) of solution per unit
   - Circulate the solution for 8-10 min having allowed the first 5 litres to run to waste
5. Rinse the plant with a minimum of 14 litres (3 gals) of water per unit immediately after the wash cycle

Include peracetic acid in an additional cold water rinse **twice daily.**

# OPTION 4: Chlorine free cleaning based on liquid detergent (sodium hydroxide) used with hot water twice daily

**After each AM milking**

1. Wash outside of clusters and jetters. Attach jetters to clusters
2. Remove or replace the milk filter sock
3. Rinse plant with 14 litres (3 gals) of warm or cold water per unit
4. Add an approved *liquid detergent (sodium hydroxide) at the recommended use rate **in hot water** at 70-80°C, allowing about 9 litres (2 gals) of solution per unit
   - Circulate the wash solution for 8-10 min, having allowed the first 5 litres to run to waste
5. Rinse the plant with a minimum of 14 litres (3 gals) of water per unit immediately after the wash cycle

**After each PM milking**

1. Wash outside of clusters and jetters. Attach jetters to clusters
2. Remove or replace the milk filter sock
3. Rinse plant with 14 litres (3 gals) of warm or cold water per unit
4. Add an approved liquid detergent at the recommended use rate **in hot water** at 70-80°C, allowing about 9 litres (2 gals) of solution per unit
   - Circulate the wash solution for 8-10 min, having allowed the first 5 litres to run to waste
5. Rinse the plant with a minimum of 14 litres (3 gals) of water per unit immediately after the wash cycle

*Replace the liquid detergent with an **acid** product on at least two occasions per week

# *Chlorine-free cleaning of bulk milk tanks:*

- **Positive: Chlorine-free bulk tank cleaning –not a problem!**
  - **All stainless steel**
  - **Always hot water**

- **Critical to re-calibrate auto washer and bulk tank washer if changing to higher caustic product (chlorine-free)-caustic content can be higher (2%↑29%)**

- **Negative : detergent suck up tubes more likely to get blocked over time**

# Cleaning protocols that can be used for a Bulk Milk Tank:

(i) Caustic detergent and acid descaler (phosphoric/nitric) used on alternate days.

(i) Caustic detergent maybe used after two milk collections and an acid detergent used after every third collection.

(i) Caustic detergent could be used after each collection followed by a rinse and then peracetic acid added to an additional final rinse.

(i) 'One for all product' used after each collection.

(i) 'One for all product' used after three collections and a caustic product used at the fourth collection.

# Milking machine cleaning routines used by the nominees of the NDC/Kerrygold milk quality awards 2020

| | Average TBC | Average Thermoduric Counts | Cleaning method | Hot washes p/wk | Water temp $^0$C | Detergent product | Acid product | Acid washes p/wk | Peracetic acid used |
|---|---|---|---|---|---|---|---|---|---|
| Peter Hamm | 9 | - | Manual | 7 | 75 | Cryosan plus | OSA-N | 14 | Romit |
| Tadhg Hurley | 4 | 117 | Manual | 14 | 78 | Alvascan Gold | Descaler | 1 | No |
| Tommy Ormond | 8 | 153 | Manual | 5 | 70/80 | Turbosan CF | Turbo Acid | 3 | No |
| John O Sullivan | 10 | 121 | Autowash | 14 | 85 | CFD100 | OptiCid | 1 | Peradis |
| William Kingston | 12 | 219 | Manual | 14 | 80 | Multisan CF | Ciro Acid3 | 3 | No |
| Patrick Banville | 3 | 174 | Autowash | 7 | 80 | CFD100 | Opticid | 1 | Peradis |
| Michael McCarthy | 3 | 220 | Autowash | 14 | 80 | CFD100 | Opticid | 2 | Peradis |
| Eugene Fitzpatrick | 8 | 114 | Manual | 14 | 80 | Asepto powder Turbosan CF | Co-op Source | 2 | Serpent |
| Conor O Brien | 14 | 100 | Autowash | 14 | 85 | CFD100 | Opticid | 7 | Peradis |
| John Keane | 8 | 200 | Autowash | 7 | 65 | Turbosan CF | Co-op Source | 4 | No |
| James McCarthy | 7 | 65 | Manual | 7 | 75 | Avalksan CF | Descaler | 1 | No |
| Joe Barry | 10 | - | Autowash | 7 | 80 | Parlorsan NC | Parlorsan | 2 | Serpent |

# Farm data-milk award nominees

- **Average TBC = 8,000 cfu/ml**
- **Average number of hot washes per week =10**
- **Average water temperature = $78^0$C**
- **Average number of acid washes per week = 3**
- **Eight farms using Peracetic acid in the final rinse**
- **Seven different detergent cleaning products used across the 12 farms**
- **No issues with Thermoduric bacteria on any of the farms**

**Key message:**

**Top quality milk can be achieved with different cleaning products if a recommended cleaning protocol is followed and if adequate hot water and adequate acid washes are in place.**

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## Why are thermoduric bacteria a problem

- Contamination of milk with thermoduric bacteria can cause processing problems for the dairy industry
- Spores exist in form capable of surviving pasteurisation
- *A count<200cfu/ml is considered normal-penalties at > 500 cfu/mL*

## Trouble shooting a high TBC or Thermoduric count

- A build up of milk residue on the internal surfaces of claw-pieces is a clear indication that there are flaws in the existing wash program
- Ideal conditions for bacterial growth--Thermodurics

New Study:

# Investigating the Farm Management Factors that Influence the Performance of Chlorine Free Cleaning Protocols on Commercial Dairy Farms.

## Objective of Study

- **To establish what management practices have the most influence on the success of CF cleaning routines on Irish dairy farms; as measured by milk total bacterial counts**
  - » **Comparing extremes;**
    - **"High TBC" dataset (≥25,000 cfu/ml)**
    - **"Low TBC" dataset (≤15,000 cfu/ml)**

## Secondary objectives;

**1) Study management factors and their impact on milk thermoduric counts;**

**2) Evaluate residue levels in farm milk and water;**

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## Materials & Methods

- 11 co-ops located nationwide have agreed to participate.
- We are targeting a sample size of approx. 100 farms.

- The number of farms visited in each co-op will depend on the overall number of suppliers that it has (min 10 farms/co-op).

- Plan to visit all farms during August, September & October

- A series of measurements will be taken such as water volumes, water temperature and detergent volumes used.

- Environmental and equipment cleanliness will be assessed using a score-card system.

- The farmer is interviewed to establish information on their overall milk quality management i.e. cleaning, milking and cooling routines.

- Farm quality data will assessed for the previous 2 months prior to the visit

# Observations from 60 farms visited last few weeks ( 8 co-ops)

- **Products:**
- Products out of date _Acid drum expired 2016, 2019
- Detergent usage_ half the rate required
- No detergent used PM
- Liquid detergent re-used
- Detergent products sitting in the sun
- Drum without label and no idea what product
- Out of detergent -days
- Long hot detergent wash cycles-15 to 20 min
- Same product levels used for both hot and cold circulation
- No acid used
- Wrong tubes in detergent/acid drums
- Peracetic acid drum open and in use 10 months
- Double the amount of Peracetic acid used
- Detergent steriliser products in use

# Observations from 60 farms visited last few weeks ( 8 co-ops)

## Washing:

- No hot water used
- Water supply issue- prolonged cleaning time
- Wash trough _ half the size required
- Low water levels for main wash cycle ( 5 litres)
- Wash water start temperature < 50 $^{o}$C for liquid products
- Hard water issue_ stain on trough surfaces- easy test
- Poor drainage after wash cycles impacted on hot wash temperature and residues
- Filter sock left in without rinsing for the full wash cycle and then replaced
- No filter sock present for the wash cycle-plate cooler
- Clusters mounted for washing in wrong position

- **Other:**
- Liners sprayed with teat dip for disinfection after high SCC cow without further rinsing
- Vacuum Airline never cleaned
- Dump lines not regularly washed
- Cows on kale and/or in sacrifice paddocks feeding silage- no teat prep

## Observations from 60 farms visited last few weeks ( 8 co-ops)

### Bulk milk tank cleaning and Milk Cooling

- No seal on tank lid- temperature/dust
- Tank cooling time-taking up to 4 hours to achieve required temperature
- Plate coolers disconnected
- Plate coolers with restricted water supply
- ESB supply issue –compressors turned off during milking; temp_ 6$^{o}$C mid-day
- Wrong tubes in detergent/acid drums
- Two caustic products on bulk tank with no acid
- No caustic product on bulk tank just an acid ( not 3:1)
- Tubes too short to reach second half of detergent in drum
- One tube in a ‘one for all product’ and both detergent & acid options manually chosen

# Main cleaning issues observed

- All farms had some deficiency in either the cleaning or cooling programmes
- Insufficient hot washes or temperatures in trough always lower than farmer expected
- Some farms using higher rates of products, which indirectly is compensating for lack of hot washes
- Automatic draining not present in many plants influencing hot wash cycle circulation temperature & potential residues
- No farm with auto wash using first dump option
- Auto-washers not recalibrated for chlorine-free products
- Rate of detergent usage lower than required in most cases and same settings used for hot and cold

# What can milking machines fitter do?

- Measure the trough to calculate the water used for detergent  cleaning
- Read the recommendations on the drum
- Establish the usage rate required for each individual wash type: Hot detergent, cold detergent, acid, Peracetic acid
- Check that tubes match the product RED = Acid: Blue =Detergent
- Check that auto drainage of plant between wash cycles is present
- If present in the Auto-washer-activate the first dump option

# How much detergent should I be using?? Depends on the water quantity in your trough

## Calculating the quantity of water used for wash cycles

Length (m) x width (m) x height (m) = cubic meters (I cubic meter =1,000 litres)

Green line indicates height of water for main wash cycle

Red line indicates height of water for rinse cycles


Step 1: To establish the width of tapered troughs: measure (m) the length across the trough at the bottom of the trough (B1) and then at the water level (B2).

Step 2: Add both measurements and divide by 2 to establish the average width. (B1+B2/2)=average width

Step 3: Measure the height (m) of water (red or green line)
Step 4: Measure the length (m) of the trough

Step 5: Multiply the width x height x length = cubic meters
1 cubic meter = 1,000 litres

Target water levels for Rinse Cycles – 14 litres per milking unit
Target water levels for the main wash cycle (hot or cold water) - 9 litres per milking unit

Length (m) x width (m) x height (m) = cubic meters (I cubic meter =1,000 litres)

**OR Length (inches) x Width (inches) x height ( inches) x 0.016**

https://www.teagasc.ie/rural-economy/farm-management/farm-machinery/machinery-calibration/dairy-wash-trough-calculator/

## Example of calculation on how much detergent should be used

- 16 unit plant (target 9 to 12 litres a unit for detergent wash)
- Trough measurement (Cubic meters) to water level for the detergent cycle- 37 Height, 42 Width, 113 length = 175,603
- Divide 175,603 by 1000 = 175 litres of water in trough (= 10.9 litres per unit)
- Detergent recommended concentration with hot water 0.7%
- To establish detergent usage rate-Multiply 175 litres by 0.7 and divide by 100= 1.23 litres of detergent

# Investigating the Effect that Chlorinated Water has on Chlorate Levels in Milk

**Objectives**

- Establish if chlorinated water containing chlorate has the capacity to contaminate milk with chlorate when used to rinse a milking machine within 2 hours of milking beginning.

- Establish if waters containing greater levels of total chlorine and by association; greater levels of chlorate result in greater levels of chlorate in milk.

- **Treatments:**

- **Control – standard Moorepark wash routine – post milking rinse, hot CF wash, post wash rinse & pre-milking peracetic acid rinse.**

- **MPK (Moorepark tap water) – 0.10 – 0.20 mg/L which is representative of the minimum levels of chlorine found at customer taps in group scheme & Irish Water supplies.**

- **0.50 mg/L – representative of higher levels of chlorine found at the tap in group schemes and typical levels of chlorine found at taps in Irish Water supplies.**

- **2.00 mg/L – representative of the maximum amount of chlorine expected to be found at a customer tap in an Irish Water supply.**

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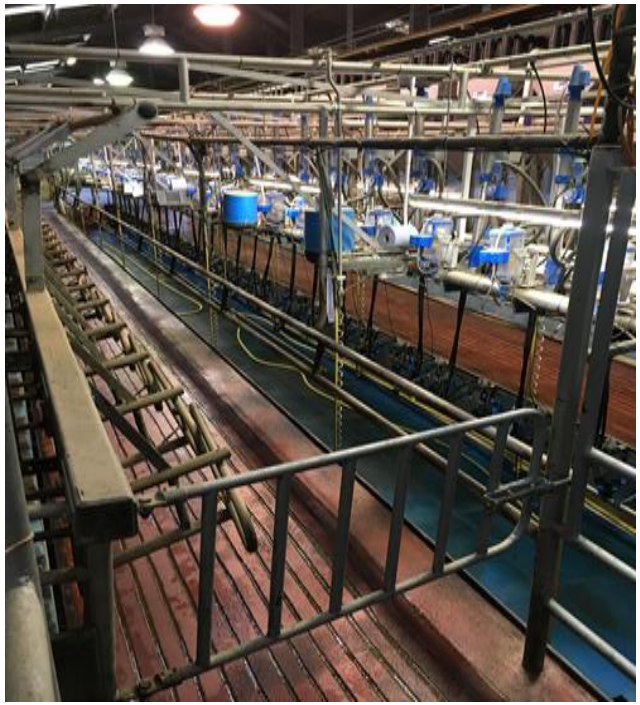
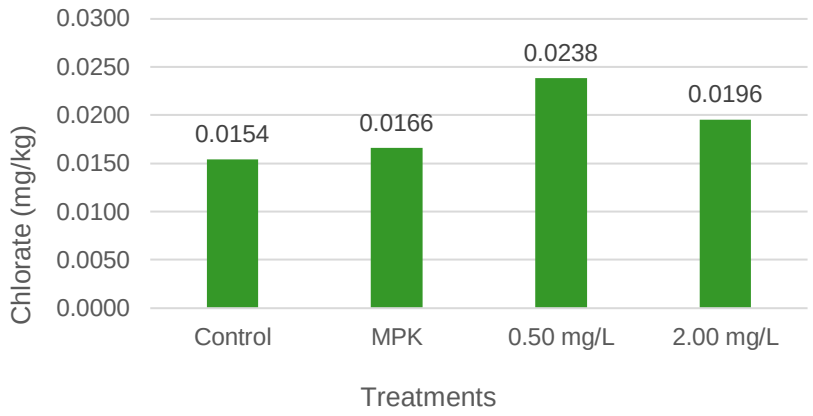
## Materials & Methods

- The trial was conducted in November/ December 2021 at the 30 unit Moorepark milking parlour
- Each rinsing treatment was applied 3 times.
- Milks from rows 1, 2 & 3 were sampled for each treatment.
- The target was to rinse the milking plant as soon as possible before milking (within 2 hours of milking).
- The 0.50 mg/L and 2.00 mg/L treatments were created using Moorepark tap plus and predetermined volumes of a 500 mg/L 10% sodium hypochlorite solution.



# Chlorate Results for Row 1 Milks




- **Chlorate was detected in milk sampled from row 1, but not detected in milks from rows 2 or 3 and this was consistent across all treatments.**
- **The detection of higher levels of chlorate was not dependent upon higher levels of chlorine and by association, chlorate in the rinse water.**
- **Instead, the detection of chlorate in row 1 milk coincided with the presence of rinse water ( freezing point)**
- **As the presence of chlorate at detectable levels coincided with extra water in row 1 milks it can be concluded that the water content of the milk dictated the presence of chlorate.**

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## Conclusions

**Based on the results of these studies it can be concluded that;**

- **Chlorinated water containing chlorate has the capacity to cause chlorate contamination of milk, but only when the two come into contact with one another.**

- **Using chlorinated water to rinse a milking machine just before milking begins will likely result in chlorate being present in milk produced by the first row of cows and subsequent rows are unlikely to be contaminated.**

- **Chlorate contamination of row 1 milk is a consequence of water (containing chlorate) in the milk**

- **To reduce the risk of chlorate contamination of milk as a consequence of rinsing the milking machine with water containing chlorate it may be necessary to take steps to minimize the amount of water that enters the milk produced by the first row of cows, such as;**

  - **Proper drainage of the plant pre-milking.**
  - **Leave first few litres go to waste**

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Thank you