Recycle Cow Water Best Practices

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In milk processing plants, a large volume of water is generated when the milk is evaporated or concentrated up using either multi-effect evaporator or process reverse osmosis. Since the source of this water is from the milk, it is commonly called cow water. Within milk processing plants, this cow water can be recycled or reused thereby reducing the demand for fresh water.

Grade A PMO Guideline Overview

The Dairy Industry uses the Federal Grade A Pasteurized Milk Ordinance (PMO) as a guideline to determine how to recycle or reuse cow water. The PMO has three categories, each of which is dependent on the end use application within a milk processing plant. The three categories are:

1. Category 1 – Used for Potable Water Purposes
2. Category 2 – Used for Limited Purposes
3. Category 3 – Used for Other Applications Not Referenced in the First Two Categories

Category 1 is the hardest category to achieve given the high water quality criteria and financial investment needed to meet that criteria. Plant criteria include:

- Compliance with a baseline bacteriological standard and the bacterial count that must be <500 colony forming units per milliliter
- Stringent initial bacteriological testing protocol that must be followed with a regular bacteriological testing every six months and include a set of daily tests for one week following any repairs or alterations of the system. For additional details on the bacteriological standard, please refer to the Grade A PMO document available online from FDA.
- Turbidity of < 5NTU or COD of < 12 mg/L
- Online fail safe monitoring devices prior to cow water storage to allow for automatic monitoring and diverting the cow water to sewer, if the turbidity or COD levels exceed the limits
- Cow water must be absent of off flavors, odors or slime formation. Weekly organoleptic testing, testing of the appearance, taste and smell, must be done.
- Need to use approved chlorine or chlorine dioxide to achieve the desired water quality. Automatic proportioning chemical feed equipment to ensure uniform treatment of the cow water is recommended.
- Daily testing to monitor and record the proper water treatment chemical residuals is required.
- Cow water must have a complete, dedicated distribution system separate from the plant's potable water lines.

With this blended makeup source, the recommended treatment approach will be a scale inhibitor, such as All Organic Treatment program 3DT265.

The main limitation of recycling cow water is organic content of the water, which will lead to microbiological challenges. Successful biocontrol is achievable in the cooling water, provided the blended makeup water cycled up COD is under 150 ppm. Nalco recommends the use of 3D TRASAR Technology for Cooling Water to monitor and control the cooling water.

Other Recycle Cow Water Applications

If the plant has achieved Category 2 requirements and excess cow water remains after considering recycling the cow water as boiler feedwater and cooling water makeup, other Category 2 applications should be considered. These applications would be CIP prerinse, cleaning solutions makeup water, case washing, and pump seals.




The local Nalco Sales Engineer will need to confirm with plant personnel what their plan is as regards the use of cow water and local regulatory requirements.

For recycling cow water as cooling water makeup, the Best Practices approach is to recommend a cow water storage tank, a system to divert heavily contaminated cow water away from the storage tank, and a system to control the microbiological growth in the cow water storage tank. Again, this recommendation is in line with the PMO guidelines.

Since cow water is not always produced during the day, the cow water storage tank is beneficially because it allows for a consistent flow of recycled cow water as cooling water makeup blended with another makeup source. Continuous cow water supply is critical to the success of the cooling water treatment.

Cooling Water Treatment Program

Nalco recommends that recycled cow water be blended with another source of makeup to ensure the blended makeup has a minimum calcium hardness of 50 ppm as $CaCO_3$. Water chemistry consistency is the key to a successful water treatment approach. As such, Nalco recommends an automated system to control the blend ratio. 3D TRASAR™ Technology for Cooling Water should be used to monitor and alarm when there is no cow water flow. An additional benefit to using 3D TRASAR automation is that when the cow water flow is lost, the cooling water will be controlled on conductivity. The conductivity will automatically adjust cycles to maintain program performance.

Nalco recommends complete water analysis including COD of the cow water along with the alternative makeup source. This analysis is important for program modeling and calculations. Since the blending calculations and 3D TRASAR Optimizer scenarios can be complex, the local Nalco sales engineer may require technical support from the Technical Expertise Center.

- If the cow water is to be used for heat exchange in a raw milk heat exchanger, multiple conditions must be met regarding operating pressure differentials and design head pressure differential. Design features must ensure proper operation and prevent product contamination when power loss occurs.

Category 2 criteria are applicable when the cow water is going to be reused as boiler feedwater for the production of culinary steam, CIP prerinsing, and cleaning solution makeup water. Although the requirements which need to be met within this category are less challenging than Category 1, they are still significant for the industry. The major difference between these two categories is that Category 2 has no baseline bacteriological standard and no regular bacteriological testing. All other requirements outlined in Category 1 must be followed for Category 2.

Category 3 is when the recycled cow water is used as boiler feedwater where the steam does not have direct food contact or as cooling water makeup where there is no direct food contact. If the cooling water leaked across the heat exchange surface, it would only contaminate another intermediate fluid and not the food product. In this category, the recycled cow water cannot be used in any circumstance where there is potential for incidental contact with milk or milk products.

Best Practices for Recycling Cow Water

The main concern associated with recycling cow water is microbiological control. Microbiological control must be assured throughout the entire system. In practice, it is most appropriate to develop a cow water recycle strategy where the cow water will meet PMO Category 2. Category 2 requirements assure good sanitation practices are in place that will ensure the recycled cow water can be used in a variety of applications within the milk processing plant.

To meet PMO Category 2 requirements without additional pretreatment of the cow water, Nalco recommends a storage tank for the cow water, a system to divert heavily contaminated cow water, and another system for online monitoring and control of microbiological growth in the cow water storage tank. This recommendation is in line with the PMO guidelines.

To detect cow water contamination, either online conductivity or turbidity meters are recommended. Conductivity or turbidity must be correlated to COD by grab sample testing. These online meters can be used to operate dump valves when the contamination becomes too high.





If the cow water is going to be stored at ambient temperature, it will be necessary to treat with a biocide for good microbio control as stated in the PMO. When the recycled cow water is being used as boiler feedwater, then the biocide recommendations should be either bleach (XY-12)or chlorine dioxide programs such as Accucide or Envirox™. These biocides are selected for a number of reasons. First, the biocides used must be rapidly and completely destroyed by the oxygen scavenger (sulfite based) in the preboiler system. Second, the biocides must be potable grade to meet the requirements of culinary steam. Third, the biocides must not break down to produce any volatile components.

If the cow water is stored at or above 145ºF, no biocide treatment is required. Insulating the cow water storage tank along with a culinary steam sparge line and temperature controller to operate the steam valve is often the best solution for maintaining this high temperature. This approach will remove the volatile organics from the water through the tank vent.

Typical cow water contamination is the organic content of the milk. For a multi-effect evaporator, the organic content, COD, is normally between 10 – 50 ppm. The final effects of the evaporator generally have higher organic content than the earlier effects. If the COD is higher than 50 ppm, the multi-effect evaporator is either carrying – over or due to be cleaned. Multi-effect evaporators tend to carryover when they are being run beyond their operating capacity. For process RO, the organic content, COD, is normally between 50 – 400 ppm.

Using Cow Water as Boiler Feedwater

For Boiler Best Practices at dairy plants, Nalco recommends following the "ASME Consensus on Operating Practices for the Control of Feedwater and Boiler Water Chemistry in Modern Industrial Boilers."

Within the milk processing plants where a multi-effect evaporator is used to concentrate the milk, the first effect off the evaporator should be returned to the boiler house as boiler feedwater without any pretreatment as it is steam/condensate. Recycling this condensate as boiler feedwater reduces makeup water and increases boiler cycles and energy savings.

Another benefit of recycling cow water back to the boilers as boiler feedwater is that it dramatically reduces the use of other makeup sources, which may contain bicarbonate and carbonate alkalinity. Therefore, the potential for carbon dioxide corrosion in the condensate can be significantly less with the recycled cow water as boiler feedwater.

In general, the first effect for the evaporator provides enough water to cover boiler feedwater needs. However, for the milk processing plants where more boiler feedwater is required, dairy plants may consider recycling the cow water from the 2nd to 5th effects of the evaporator or using process reverse osmosis permeate. The first step is to confirm if culinary steam (direct steam contact) is a requirement, which will determine if the plant needs to follow Category 2 or Category 3.

For Category 2, the COD needs to be less than 12 ppm as O_2 ppm.

For firetube boilers, the ASME guidelines require that the non-volatile TOC must be less than 10 ppm as C or 26.67 ppm COD as O_2 ppm.

For watertube boilers, the ASME guidelines require that the non-volatile TOC must be 1 ppm as C or 2.67 ppm COD as O_2 ppm.

It is important to note, the ASME guidelines are for non-volatile TOC where much of the COD in the cow water is small volatile compounds, such as ethanol and acetone. These volatile organics present no operational boiler problems as most will be effectively stripped out by a well operating mechanical deaerator. To ensure the ASME guidelines are being meet, COD or TOC testing should be performed on the deaerator boiler feedwater.

The other contaminate found in cow water is hardness. Hardness is typically seen with process RO units or when there is carryover from the multi-effect evaporator. It is important to monitor on a daily basis the total acidified hardness level in the recycled cow water. Total acidified hardness needs to be monitored because the calcium hardness may be associated with organic species, and the soluble hardness will give you a lower hardness level.

Boiler Treatment Program

NexGuard™ 22310 is the recommended internal treatment program for the majority of recycled cow water applications where ASME feedwater guidelines are followed consistently.

Another Boiler Best Practices recommendation is the use of boiler antifoam Nalco 750. Boiler antifoam is effective in addressing boiler foaming caused by organic contamination along with increasing the boiler blowdown rate.

Using Cow Water as Cooling Water Makeup

Most open recirculating cooling water applications, such as evaporative ammonia condensers, evaporative glycol coolers or other chiller applications have indirect contact with the milk and milk products within a milk processing plant. Therefore, most cooling water applications would fall under Category 3.