Heat Exchanger Cleaning Procedure

for

Thermal Treatment of Milk in the Chemical and Biological Engineering Senior Lab

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# Process Overview

*The Chemical and Biological Engineering Department operates multiple undergraduate laboratories. The senior unit operations laboratory is used by 20 to 60 students a semester to complete multiple laboratory experiments in the Clyde Building Room 217. Some of the students will participate in learning more about heat exchangers to apply that knowledge to heat treating milk for use in making ice cream. This procedure describes necessary steps in cleaning and sanitizing the heat exchanger setup used to thermally treat the milk.*

# REQUIRED PPE

*This procedure includes the use with caustic and acidic substances. A lab coat, gloves, pants, closed toe shoes, safety glasses is required. When working with the acid and caustic solutions, also wear nitrile gloves and a face mask.*

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| **Step** | **Description** | **Verification** |
| 1 | Drain the setup of water if present (it should not be) |  |
| 2 | Wipe down the area above the tank where the t-slot holds and support some of the piping with sanitary wipes which contain bleach or other sanitizer. Also wipe down the edge of the tank under the cover and down into the tank about a three quarter of the way down (where the hot water will not reach) in the below steps. Use a vacuum if necessary and ensure that dust or debris is not present; wear ear protection as needed. |  |
| 3 | Fill the tank and system such that the water level is above the outlet port of the water to approximately three quarters full (around 7.5 gallons or a fill time of approximately 115 seconds). The cover on the tank should be present. You may need to close the valve. |  |
| 4 | Cycle the water with the pump through the system for 30-60 seconds. |  |
| 5 | Rotate the ball valve to allow the steam to enter the heat exchanger. Set the steam pressure to 10 psig. Allow the steam to heat the water until the temperature reaches 80C as indicated by the inlet temperature to the heat exchanger. You will have to turn the steam pressure down to 2-5psig as the temperature gets closer to 80C (maybe around 70C or lower) so that the water in the tubes of the heat exchanger does NOT start to boil or vaporize. Keep the water flow rate as high as it will go with the flow rate valve fully open to help prevent the boiling of the water.  Steam pressure adjustments are made on the control software after opening the manual valve on the equipment. Do not linger around the steam connections and alert the lab manager or TA if you notice any leaks. |  |
| 6 | Once the temperature reaches 80C as measured by the inlet temperature, cycle the water for 5 minutes at the highest flow rate. |  |
| 7 | After flowing for 5 minutes, add 25mL/L or 95 mL/gallon of Ecolab Conquest (containing sodium hydroxide) and circulate for 30 minutes. |  |
| 8 | After 30 minutes, drain at least three gallons through the offload port two - three times. In other words, drain 1-3 gallons through the off load, close the valve, return the liquid to the tank. Then again open the valve and drain 1-3 gallons through the off load port and return that to the tank. |  |
| 9 | Drain the contents of the tank through the drain valve with the drain valve open 25%. |  |
| 10 | Cycle water through the system and a few times out the offload port (returning the water to the tank) until the pH is 7.5 or lower. You may have to fill and drain the tank a few times. Take a sample of liquid through the offload port into a beaker. Use pH paper or a calibrated probe to measure the pH. | pH measurement |
| 11 | Fill the tank again to ¾ full. Ensure that the steam valve is closed. |  |
| 12 | Add Ecolab Heavy-Duty Acid LC-30 at 15mL/L or 57 mL/gallon to the tank. |  |
| 13 | Cycle the system for 15 minutes. Again take 1-3 gallons off through the outlet two-three times and return to the tank what was drained. |  |
| 14 | Drain the contents of the tank. |  |
| 15 | Cycle water through the system and a few times out the offload port (returning the water to the tank) until the pH is 6.5 or greater. You may have to fill and drain the tank a few times. Take a sample from the off load port into a beaker. Use pH paper or a calibrated probe to measure the pH. | pH measurement |
| 16 | Make sure to close the drain valve! |  |
| 17 | Begin to add the milk and complete the thermal treatment at 75C for 15 seconds with the student led recipe. |  |

Notes:

The first time I did this it took about an hour and a half (CGG on Aug. 26, 2025). Concerns I had:

* Splashing hot caustic (or acid) from the outlet valve when draining the tank 3 times to ensure that the drain port is also cleaned and sanitized