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Energy-Water Reduction and Wastewater Reclamation in a Fluid Milk Processing Facility

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Introduction

The energy-water nexus is the inseparable connection linking water and energy. We are faced with a unique opportunity to co-manage these resources, as conservation of one is directly linked to the conservation of its counterpart. Therefore, immediately facing this critical challenge, will lead to tangible impacts on the water and energy crisis our food system is faced with. Determining the role of water and energy in the food industry has proved to be the starting point for reducing the distance between process productivity and resource efficiency. Therefore, this research focuses on determining opportunities for water-energy optimization and wastewater reduction and reconditioning in a medium sized dairy plant processing pasteurized fluid milk. The long term goal of this research is to transform our findings into a set of industry wide guidelines that will create a culture of water and energy conservation.

Objective 1. To determine the baseline quantities of water and energy consumed by a medium sized dairy plant and to locate potential areas for source reduction

Objective 2. To design treatments for reconditioning and reuse of the premier location of wastewater generation

Process flow

Materials and Methods used:
1. Designed a process flow diagram
2. Determined inputs (water, milk, natural gas, electricity) of fluid milk processing
3. Determined outputs(wastewater) of fluid milk processing

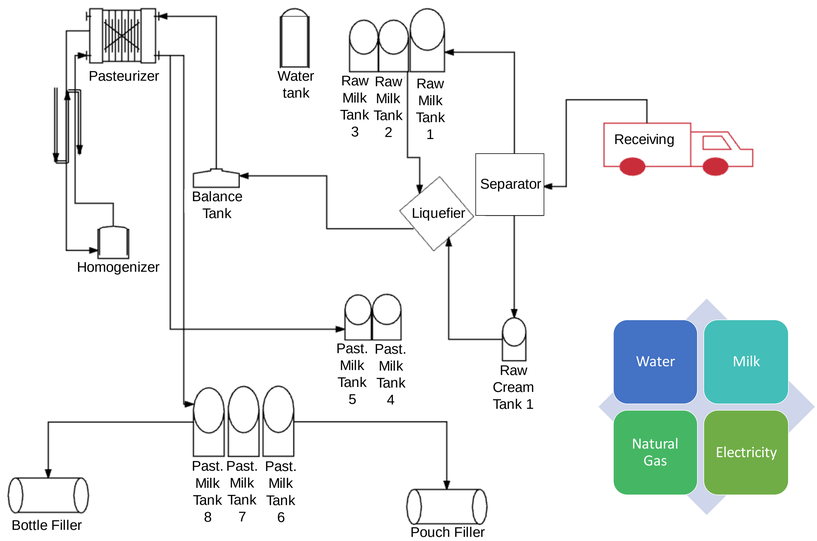
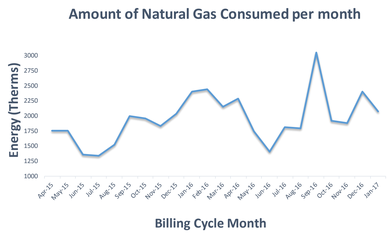


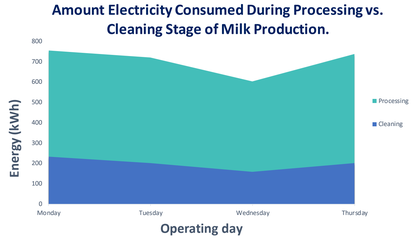
Figure 1: Process Flow Diagram of Fluid Milk Processing in a Medium Sized Dairy Plant

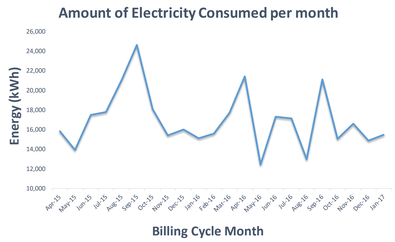
Discussion:
- It was uncovered that the production of milk involves many high energy processes, including: receiving, separation, standardization, HTST pasteurization, cooling , and packaging of milk
- The medium sized dairy plant that this research was conducted in, produces 7,262 gallons of milk each day

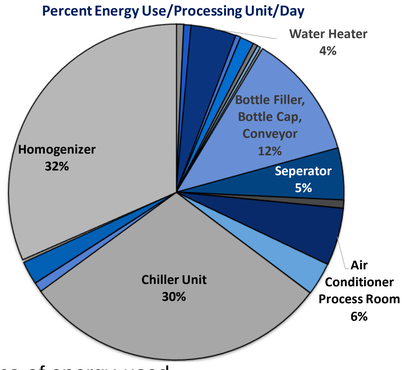
Energy Consumption

Materials and Methods used:
1. Collected and consolidated utility bills
2. Collaborated with electrical company to install meter that would allow for single unit identification of kWh consumed





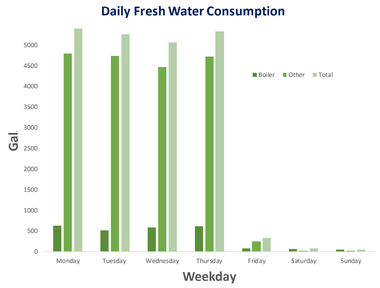


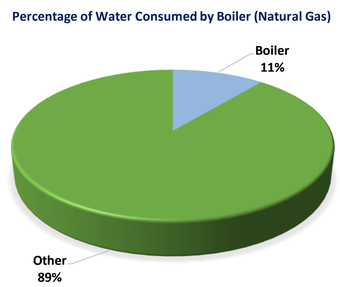


Discussion:
- Electricity and Natural Gas are the two forms of energy used
- 24.84% of the total kWh consumed during an average production day is utilized for cleaning operations
- Natural gas is solely used to heat water through steam production
- The largest consumer of electricity is the homogenizer. This machine runs during both the processing and cleaning operations
- The remaining 11% of energy consumers consists of: lights, agitators, tank pumps, compressors, pouch filler, liquefier, transfer pumps, and pasteurizer panel

Water Consumption

Materials and Methods used:
1. Collected and consolidated water billed data
2. Installed two inline meters to monitor water consumed by boiler and hourly water consumption

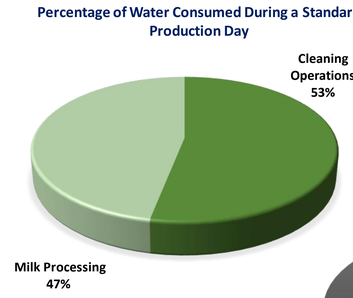


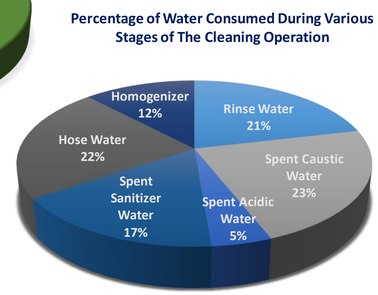


Discussion:
- Boiler feed water Is utilized during pasteurization, automated, and manual cleaning
- Other water is involved with separation and homogenization of milk and acidic sanitization

Wastewater generation

Materials and Methods used:
1. On site visits were made to determine where wastewater was being generated
2. Analyzed times of mass water consumption based on inline meters
3. Performed water balance for cleaning stage





Fluid Milk Processing Consumption

Utility	Unit	Amount used
Electricity	kWh/ gal. finished milk	0.13
Natural Gas	Therms/gal. finished milk	0.02
Fresh Water	gal water /gal. finished milk	0.85
Wastewater	lb. wastewater/gal. finished milk	5.26

Discussion:
- Over 53% of the total water, is taken up by the cleaning operations. Therefore future focus will be on cleaning operations as means for source reduction
- The water consumed during cleaning is utilized during multistage cleaning in place systems, cleaning out of place procedures, floor cleaning, and the running of the homogenizer
- The homogenizer consistently produces wastewater during the milk processing in addition to cleaning
- It was determined that 74.35% of the fresh water brought into the plant became wastewater

Research Impact

1. Assisting dairy plants in process optimization
2. Water and energy conservation and wastewater reduction
3. Reclamation of wastewater generated

Future Steps

1. To perform a risk-based assessment/ simulation for the reuse of recovered cleaning in place wastewater
2. To implement recommended protocols for increased source productivity
3. To determine the effectiveness of implemented recommendations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