Cleaning and Sanitizing with Electrolyzed Oxidizing (EO) Water

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Cleaning Is Critical

- About 10,000 dairy farms in Pennsylvania
- Milking equipment must be cleaned and sanitized after every milking session (2 or 3 times daily)
- U.S. law required raw milk to contain less than 100,000 CFU/ml (aerobic plate count)
- Good cleaning practices = more money

Current Standard Practice

The Northeast Dairy Practices Council recommends a four-step cleaning process:

1. Initial Rinse
2. Alkaline Wash Cycle
3. Acid Rinse
4. Sanitizer

Electrolyzed Oxidizing (EO) Water

- Separates chlorine ions from sodium ions in a weak sodium chloride solution
- Produces an alkaline solution (sodium ions) and an acidic solution (chlorine ions)

Alkaline Water:

- pH of 11.4
- Oxidation Reduction Potential (ORP) of -795 mV

Acidic Water

- pH of 2.6
- 50 - 80 ppm free chlorine
- ORP of 1150 mV

EO Water Generator

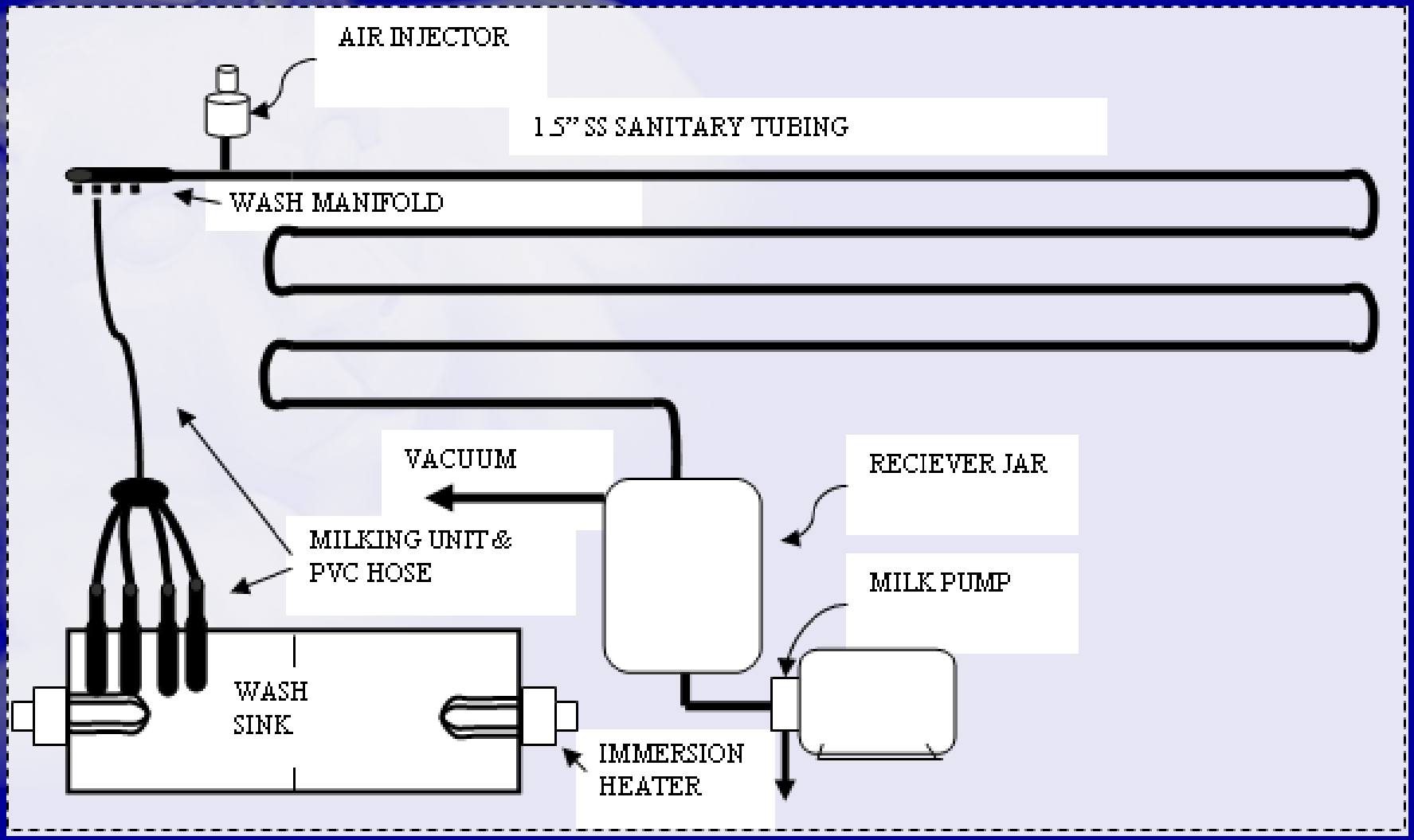
Effectiveness of Acidic EO Water

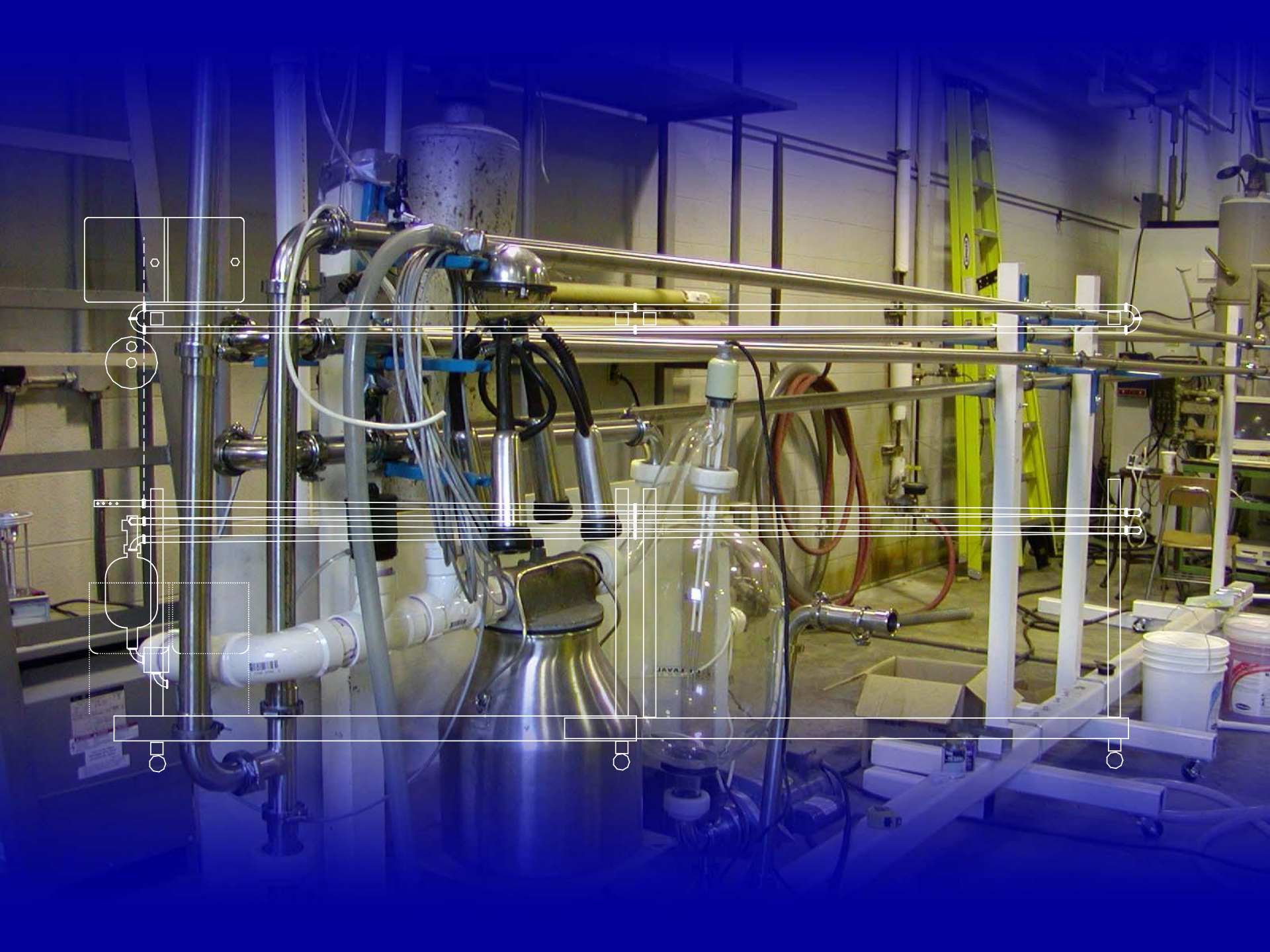
- Foodborne pathogens in solution
- Pathogens on surfaces of fruits and vegetables
- 9-log reduction of *Listeria monocytogenes* on stainless steel
- Effective at eliminating *E. coli O157:H7* on plastic cutting boards

EO Water

- Not harmful to the skin for short contact times
- No on-farm storage of highly concentrated, highly caustic chemicals
- Once machine is purchased, consumables are only sodium chloride and electricity

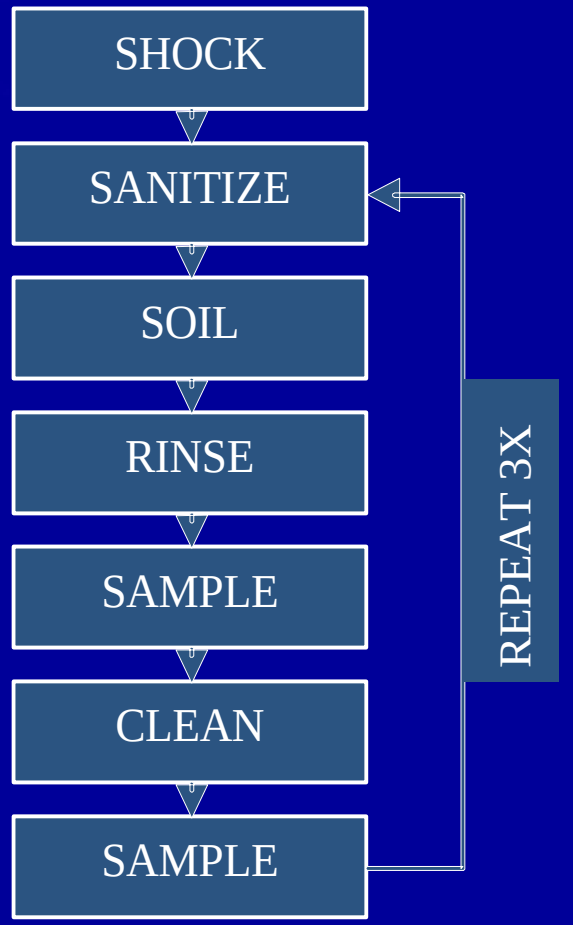
Diagram of a Milking System





CIP Cleaning

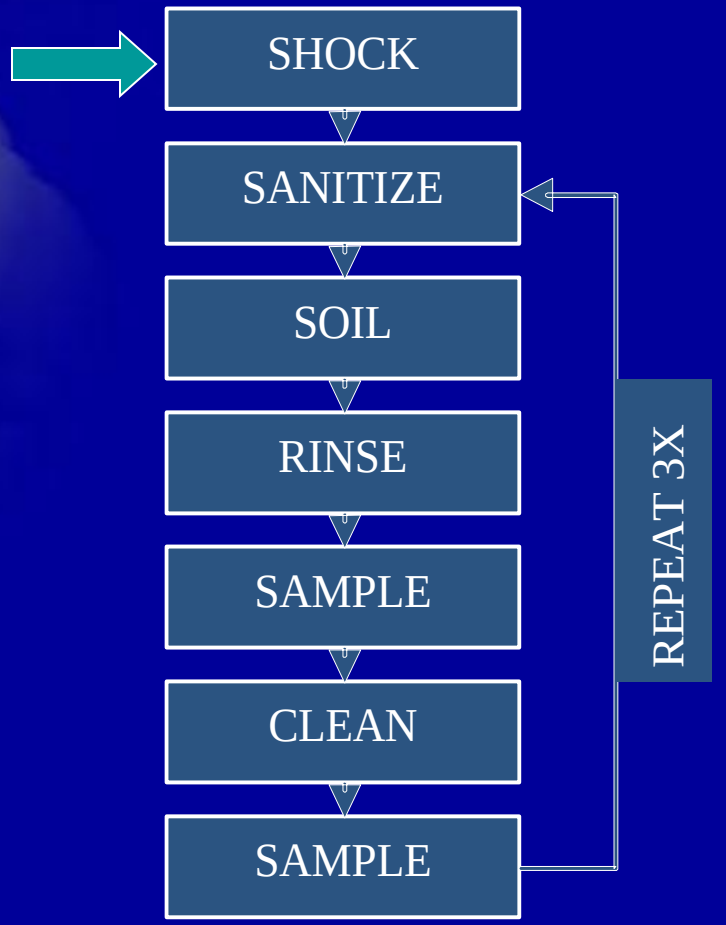
A single soiling/cleaning cycle evaluated at three treatment times (10-min, 7.5-min, and 5-min) with EO Water and then also with conventional treatment.



CIP Cleaning

Shock

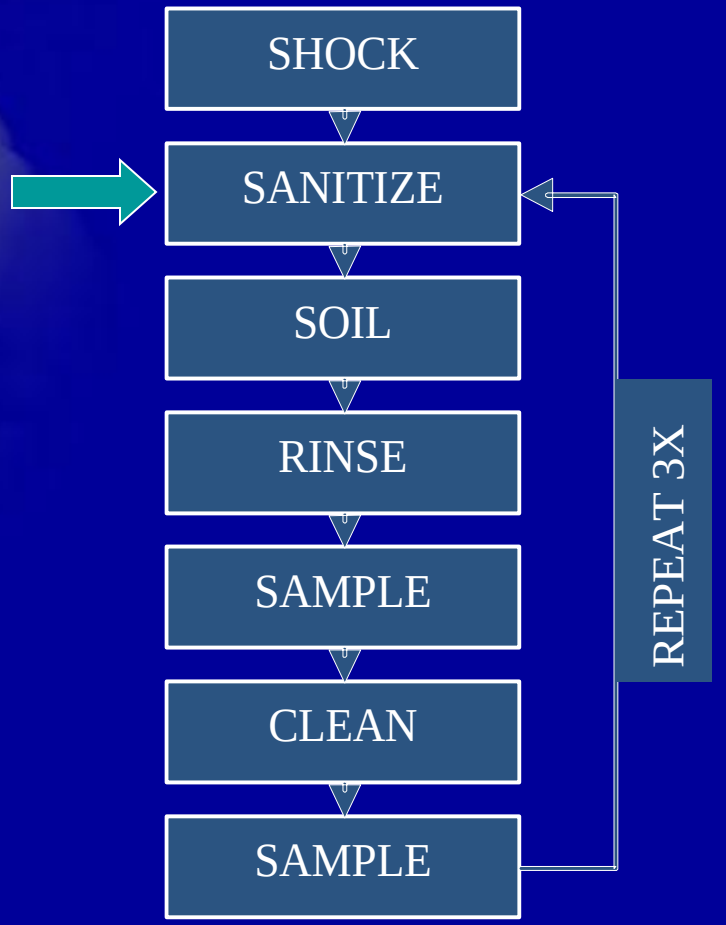
Clean system with a hot (85°C) chlorinated alkaline cleaner with the addition of granulated lye and rinse with warm acid treatment



CIP Cleaning

Sanitize

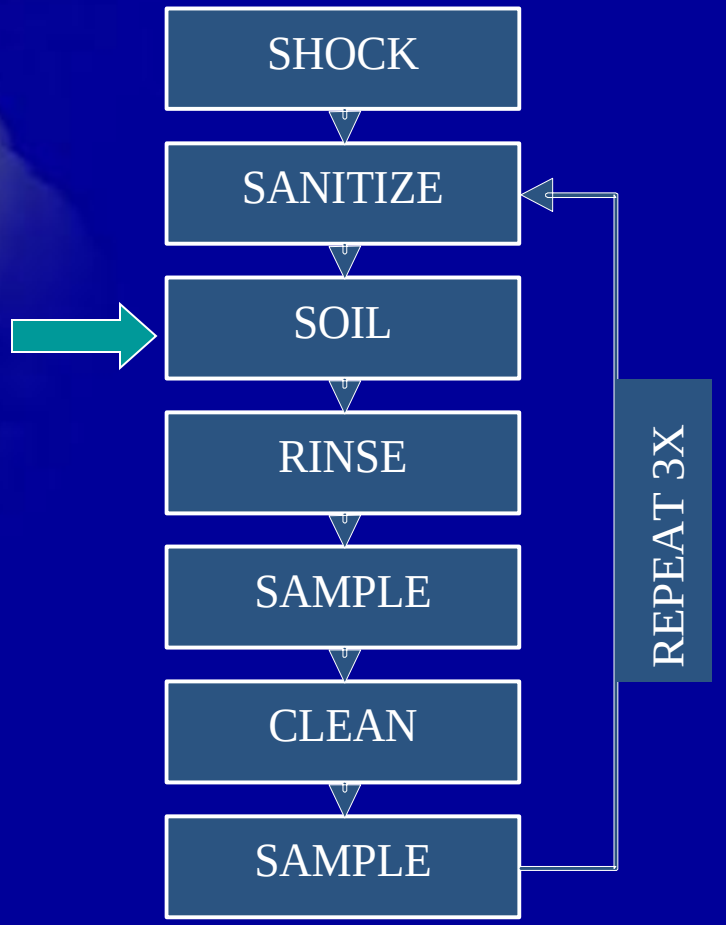
Rinse system with sodium hypochlorite sanitizer solution at standard strength



CIP Cleaning

Soil

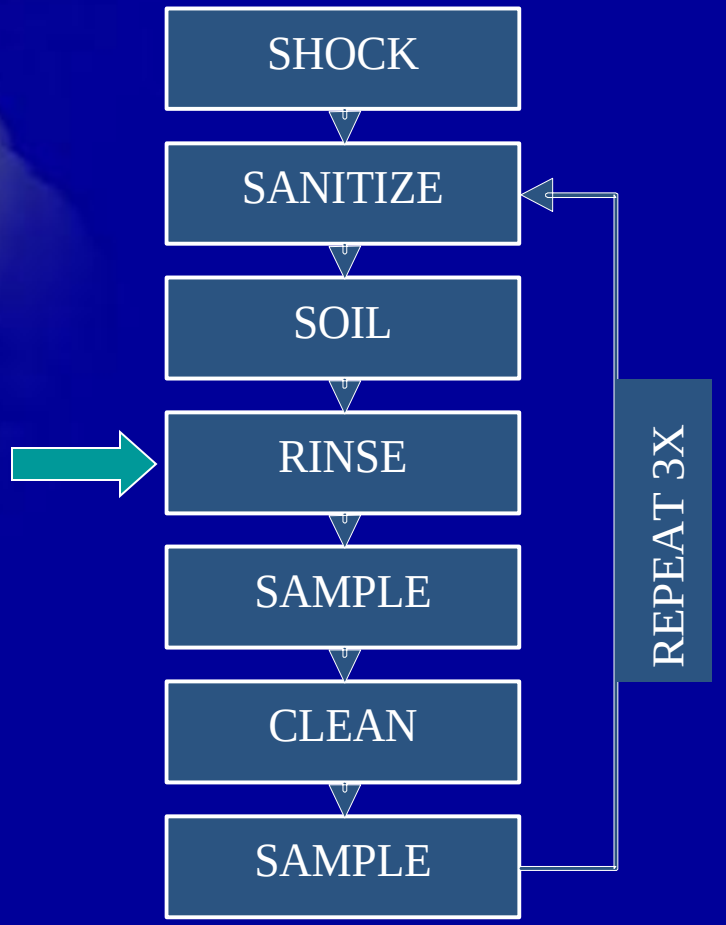
- Scale up of laboratory innoculum – 4 bacteria species @ 500ml
- Culture broths were centrifuged and biomass added to 10 gallons of raw milk that has been warmed to 38°C
- Introduced into system in 3 stages with a 10 minute pause between each stage



CIP Cleaning

Rinse

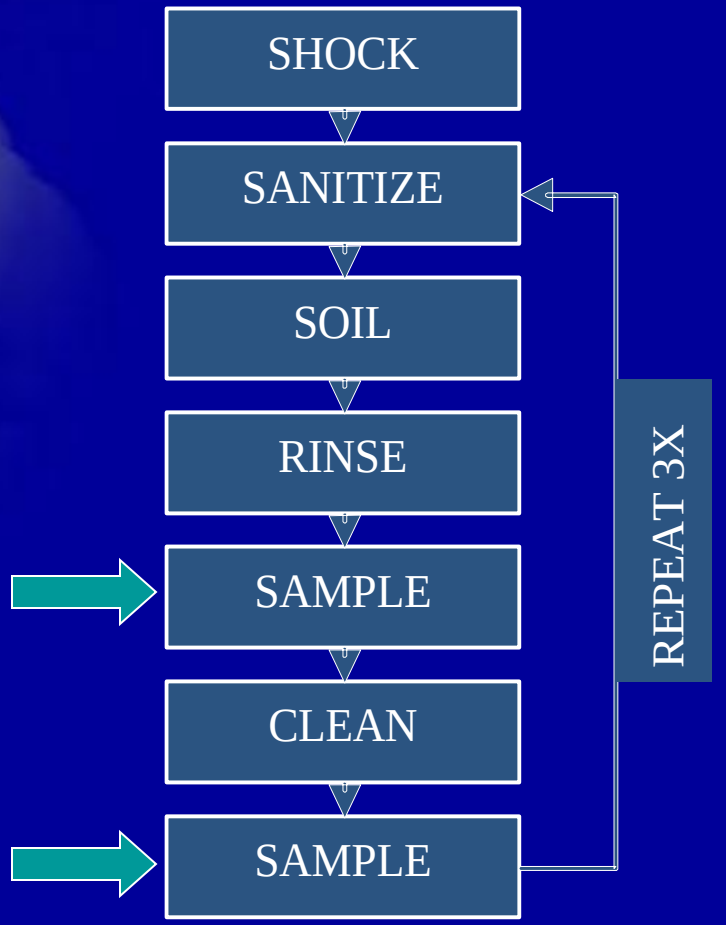
Rinse system with warm (about 40°C) water to remove fluid milk



CIP Cleaning

Sample

- 5 Locations: Rubber liners, S.S. elbows, S.S. straight sections, plastic claw, neck of glass receiver jar
- 8 samples each for ATP and Plate Count
- Post-cleaning samples also evaluate PVC milk hose and interior of receiver jar



ATP Evaluation

- After treatment, each sample was swabbed with PocketSwab Plus (Charm Science, Inc.), for 6 seconds, roughly covering the 10cm^2 area.
- Pocketswab was evaluated in LUM-T luminosity meter.
- Results were reported directly as RLU score (Clean = RLU score of 0)

LUM-T and PocketSwab Plus

- Enzyme luciferase catalyzes a reaction with ATP that emits light
- PocketSwab is self-contained pre-moistened swab including reagents
- Light levels are read by “Luminator” unit and reported as an RLU score

Bacterial Evaluation

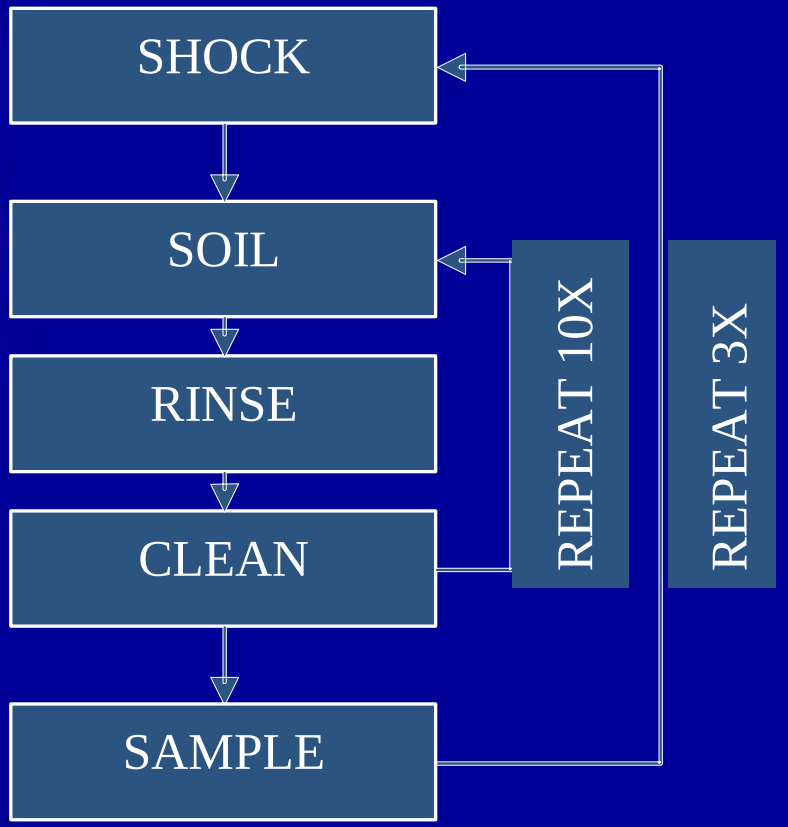
- After treatment, each sample was swabbed with sterile calcium alginate swabs
- Swabs were washed in 9 ml of buffered peptone water
- Peptone water was diluted and plated on SPC Agar
- Another set of samples was inoculated but not treated so that initial contamination may be evaluated

Results:

- High RLU scores indicate failure of cleaning at 5-min treatment.
- Most bioluminescence swabs show no detectable ATP on stainless steel parts for 7.5-min treatment, however there were some non-zero readings
- For 10-min treatment, luminosity readings showed presence of ATP in all before-treatment samples, and showed NO detectable ATP after cleaning (except for rubber liners, which may be acceptable)

CIP Cleaning: Long Term

Long term evaluation of 7.5-min EO Water treatment and also conventional treatment.



Results: Long Term

Treatment	Location	ATP Initial (RLU)	Enrichment Initial	ATP Final (RLU)	Enrichment Final
Conventional	Claw	9177	3/3	6757	1/3
	Elbow	18092	4/6	756	1/6
	Liner	15162	6/6	1395	0/6
	Pipe	13869	4/6	979	2/6
	Receiver	9868	2/3	0	0/3
EO (10 min)	Claw	6611	3/3	114	1/3
	Elbow	15196	6/6	0	2/6
	Liner	16148	6/6	776	1/6
	Pipe	14111	6/6	0	0/6
	Receiver	7359	3/3	0	0/3

Walker, S. P., A. Demirci, R. E. Graves, S. B. Spencer, and R. F. Roberts. 2005 Transactions of ASAE. . 48(5): 1827-1833.

Results: Long Term

The system was not sufficiently cleaned by the 7.5-min EO water treatment:

- Several non-zero ATP scores
- Visible soil on some parts
- 7.5-min treatment could have been too short

Future Research

- Further optimization of the process needed to gain success in long term evaluation
- Evaluate one or more other EO water equipment.
- Conduct on-farm trials at commercial dairy farm
- USDA funding has been secured.

Acknowledgements

Dr. Stephen Walker
Dr. Robert Graves
Dr. Stephen Spencer
Dr. Robert Roberts
Hoshizaki Electric Co. Ltd.


Any Question?
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