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WORLD BREWING CONGRESS 2016

# SURFACE ACTIVE TECHNOLOGY PROVIDES A STEP CHANGE IN THE USE OF SINGLE PHASE ACID CLEANER WITH CIP OF CELLAR TANKS UNDER $CO_2$ ATMOSPHERE

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World Brewing Congress
August 13-17, 2016
Sheraton Downtown Denver
Denver, CO 80202, U.S.A.

## Abstract:

Cleaning of the fermentation and maturation vessels is normally accomplished by a cleaning process that requires an alkaline phase and an acid phase to be able to remove protein (cold trub & yeast), and beer stone ($CaC_2O_4$). For the alkaline phase to be effective and safe for the operation, the $CO_2$ must be vented to avoid neutralizing the alkaline solution and creating vacuum that could implode the tank being cleaned. The removal of the $CO_2$ takes time that adds to the cleaning program of each tank. One solution to avoid venting the tanks is to clean only with acids, but then the protein removal effectiveness is compromised as even formulated acid cleaners are not as good as alkaline detergents removing protein film. This paper will focus in the implementation of surface active technology to achieve cleaning of fermenters and maturation tanks under $CO_2$ atmosphere with a highly effective one phase acid cleaner. This implementation saves time and water while maintaining the results achieved with traditional programs.

## Background:

Cleaning programs of tanks in the cellars are related to the soil level and the risks associated with remaining oxygen presence in the tanks after the cleaning and sanitation. In the case of the fermentation (FV) and maturation vessels (MV) , the soil level is high (yeast, hop oils, proteins, beer stone) and requires several cleaning steps to be able to remove the organic and mineral deposits left , followed by a sanitation. All cleaning and sanitation is done at ambient temperature which poses an additional challenge for the chemistry used.

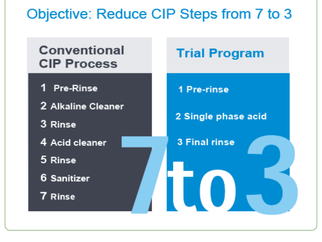
A general cleaning and sanitation program for FV/MV follows these steps:

| Steps | Conc. % V/V |
|---|---|
| Pre-rinse | |
| Alkaline step | 2.0-2.5 |
| Rinse | |
| Acid cleaner | 1.0-1.5 |
| Rinse | |
| Sanitizing step (peracid type) | 0.3-0.5 |
| Rinse | |

**7 steps**

The use of alkalis at cleaning concentrations requires the $CO_2$ to be first removed from the FV/MV to avoid neutralization and vacuum as a result of the reaction with NaOH. The vacuum created will be proportional to the concentration of both reactants and represents a risk for irreversible tank damage. **Removal of $CO_2$ can take 45-120 minutes depending of the size of the vessels and method of removal.**

The use of surface active technology has been documented and tested to provide an additional mechanical action for the removal of difficult soils. The objective of this study was to use this type of technology in combination with a high performance single phase acid cleaner to eliminate the need of an alkaline step when doing FV/MV CIP. By eliminating CIP steps the plant would realize significant savings in time, energy, chemical use and water. The study also looked to use a Phosphate free formulation to reduce the impact on the wastewater treatment plant.




## Field trial: Mid-Size brewery of a global brewer

**Brewery data:**
- ✓ ~2,100,000 HL/year
- ✓ Re-use CIP
- ✓ 14 MV
- ✓ 19 FV

**Portfolio:**
- ✓ Lager Beers
- ✓ Malt beverages

**Cleaning protocol for FV/MV**

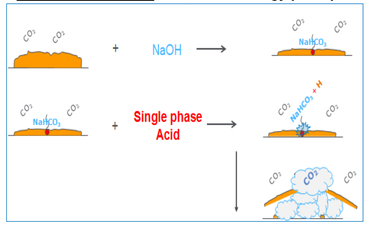
| Current | |
|---|---|
| **Steps** | **Conc. % V/V** |
| Pre-rinse | |
| Alkaline step | 2.0-2.5 |
| Rinse | |
| Acid step | 1.0-1.5 |
| Rinse | |
| Sanitizing step | 0.3-0.5 |
| Rinse | |

7 Steps

| Field trial | |
|---|---|
| **Steps** | **Conc. % V/V** |
| Alkaline Pre-rinse | 0.5-0.8 |
| Single phase Acid | 1.5- 2.0 |
| Final Rinse | |

3 Steps

**Alkaline Pre-shots: Surface technology principle**



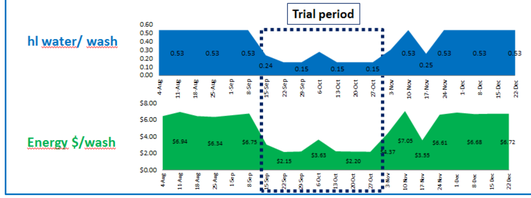

## Field trial results:

**Alkaline Pre-shots trial results:** Alkaline pre-shots were used after safety evaluation and vacuum calculations verification to protect vessel integrity

Fermentation vessel, 10 pre-shots

Maturation vessel, 6 pre-shots

**MV CIP water & energy consumption during trial and annualized savings:**




| | Water | Effluent | Energy |
|---|---|---|---|
| Conventional | $3,938 | $11,409 | $1,847 |
| Trial Program | $1,138 | $4,776 | $695 |
| Savings | $2,800 | $6,724 | $1,152 |

**MV CIP time consumption and capacity increase during trial:**

| Conventional | |
|---|---|
| Cleaning time: 3.78 Hours / CIP | |
| **Steps** | **Time (min)** |
| Preparation & rinse | 120 |
| Alkaline Step | 35 |
| Acid Step | 30 |
| Sanitization Step | 20 |
| Rinse | 22 |
| TOTAL | 227 |

| Trial Protocol | |
|---|---|
| Cleaning time: 1.08 Hours / CIP | |
| **Steps** | **Time (min)** |
| Preparation & pre-shots | 20 |
| Single phase Acid | 30 |
| Rinse | 15 |
| TOTAL | 65 |

Reduced cleaning time by 2.7 Hrs

**Conventional**

1. * Cycle time: 5826 hrs./year
   - Filling time: 180 hrs.
   - Processing time: 4842 hrs.
   - Empting time: 225 hrs.
   - **Cleaning time: 179 hrs.**
   - Idle time 400 hrs.
2. Production: **61,186** concentrated HL/week

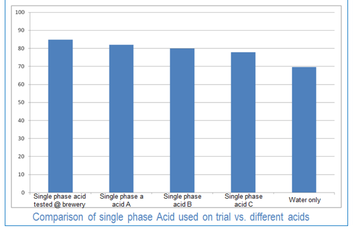
**Trial Program**

1. * Cycle time: 5691 hrs./year
   - Filling time: 180 hrs.
   - Processing time: 4842 hrs.
   - Empting time: 225 hrs.
   - **Cleaning time: 44 hrs.**
   - Idle time: 400 hrs.
2. Cycle reduction: 135 hrs./year
3. Production: **62,639** concentrated HL/week

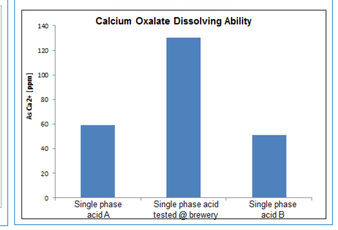
* Cycle time= Filling time+ Processing time+ empting time+ cleaning time+ Idle Time

## Cleaning testing lab research:

Removal of *Brandhefe* of Acid Cleaners




Beerstone removal




## Conclusions:

- Trials on a medium size plant of a global brewer confirmed that surface cleaning technology, in combination with a single phase acid cleaner can achieve similar cleaning and sanitation results than traditional programs.
- The program tested in this trial on maturation vessels reduced the cleaning steps from 7 to 3 steps. Similar results were achieved on Fermentation vessels on a later trial. Key for the reduction from 7 to 3 steps is the use of a single phase acid.
- The additional mechanical action provided by the surface active technology makes possible to use low concentration alkaline pre-shots under $CO_2$ pressure, and achieve good removal of *Brandhefe* ring residues. Tank safety devices must be in working conditions and calculations are needed to eliminate the risks associated with vacuum.
- The reduction of steps has a direct impact in the reduction of time, water and energy. Time reduction impact on productivity can vary from plant to plant. The impact on productivity increases in plants where cellar tank availability is a bottleneck.
- The single phase formula tested on the brewery is phosphate free. The wastewater treatment plant was not affected during the trial period.

Summary of trial results: Sustainability, productivity & safety indicators

WATER **120,000 HL**

ENERGY **10,000 KW**

WASTE **64.000 HL**

SAFETY ***Decreases employees exposure to $CO_2$***

PRODUCTIVITY **Decreased** each CIP cycle time by **3 hours**

Added **224 hours** of production time per month

PROFITABILITY **Increased** incremental profits **$1M USD annually**

**Boosted** production by **>1,450 hectoliters** per week

WATER Annually **reduced** water used by **12,000 Cubic meters** & effluent waste by **6,400K Cubic meters**