CIP (Clean in Place) Optimization

Realize water, energy and detergent savings while by improving CIP in food industry.
Introductions

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Cleaning of Processing equipment

To ensure safety, processing systems must be kept clean and free of undesired microorganisms. This is achieved by various types of cleaning methods.

- **COP - Clean Out of Place**
- **CIP - Clean-In-Place**
- **SIP - Sterilize-In-Place**

Session will look at best practice use of instrumentation and hygienic design to enhance food safety while reducing operating costs and product losses related to CIP.
Why Hygienic design?

- Safety and quality:
  - Less danger of product mixing
  - Less risk for undeclared ingredients (allergens)
  - Reduce microbiological threats

- Costs:
  - Time saving in phase shift operations = more up time for production
  - Less mixed phases = less product losses, less waste load
  - Less chemical use in CIP = less direct costs and less waste load
  - Less energy needed to reach cleaning temperatures on all surfaces = direct cost
  - Faster cleaning = more up time for production
Are the cost savings real?

Too much water for CIP?
In last year’s column I mentioned that the dairy industry has an opportunity to save money — potentially big money. My colleague Craig Nelson of Food Automation LLC had estimated clean-in-place (CIP) water overuse per plant, on average, was 25,000 to 30,000 gallons a day.

In 1986 Roy Carawan told dairy CEOs that they had a $500 million water-saving opportunity. Adjusted to today’s rates, we may be sitting on a billion-dollar opportunity. It behooves me to say: Dairy processors have not been sitting on their duffs all these years, so the exact size of the opportunity is hard to pinpoint. What I can say is whatever you are paying today will be more next year and even more in the years ahead.

Water and wastewater must be properly managed, whether for altruistic reasons or a pragmatic contribution to the bottom line.

Clay Detlefsen is vice president for regulatory affairs for the International Dairy Foods Association, Washington, D.C.

Article in April 2013 Dairy foods magazine
At $3.00/1000G cost for water and $3.50/1000G waste water the potential savings of $70K/year
Hygienic design: What and who is involved

What has an effect:

- Material of construction
- Surface finish
- Design of product and non-product contact surface
- Installation best practices

European /American organisations

EN1935/2004
IFS 6 (International Featured Standards)

4.17 Equipment

4.17.1 Equipment shall be suitably designed and specified for the intended use. Before commissioning, it shall be verified that the product requirements are complied with.

4.17.2 For all equipment and tools with direct food contact, certificates of conformity shall exist which confirm compliance with current legal requirements. In case no specific legal requirements are applicable, evidence shall be available to demonstrate that all equipment and tools are suitable for use. This applies for all equipment and tools in direct contact with raw materials, semi-processed and finished products.

4.17.4 The company shall ensure that all product equipment is in good condition without any negative influence on food safety.

4.17.5 The company shall ensure that in the event of changes to processing methods and equipment, process characteristics are reviewed in order to assure that product requirements are complied with.
3-A Sanitary Standards

- Not true regulations - only standards
- Applicable to “Grade A” milk and milk products
- Manufacturer self-certification with third party verification conformance to the standards
- 3-A does not approve anything – a device “meets with 3-A sanitary standards”
- 3-A sanitary standards are recognized by the FDA and to some extent by USDA when related to dairy products.
- Not recognized by USDA for Meat and Poultry
- 3-A is a legal requirement in Dairy operations, many other food branches request it as it is seen as good practice.

www.3-A.org
Design criteria : 3-A Design Standards

1) Scope of standards
   Statement of intent for equipment

2) Definition of terms
   Define products, product contact surfaces, non-product contact surfaces,
   specific terms of the equipment, and definition of the equipment itself

3) Description of permitted materials
   Define materials which compose the equipment

4) Details of fabrication
   Sanitary design is effected by fabrication: finish, limits of radii, self-draining
   characteristics, accessibility for inspection of cleaning, design for mechanical
   cleaning, and integrity of product contact surfaces

5) Appendix
   Information unique to equipment construction or installation
EHEDG – European Hygienic Engineering and Design Group

- Organization established in mid 1990’s to by larger European food producers and equipment mfg. To establish uniform requirements for Europe
- Provides recommendations to ISO for sanitary standards design
- Equipment has to pass test to qualify as EHEDG compliant
- EHEDG Test process
  - Device to be tested is installed on test rig
  - Rig is cleaned (CIP)
  - Test rig is soiled with bacteria (often sour milk)
  - Test rig is cleaned (CIP)
  - Rig is filled with test media SHA which discolors when exposed to bacteria
  - Test sample is evaluated compared to reference sample

www.ehedg.org
Surface Finish - Conversion

<table>
<thead>
<tr>
<th>Grit (Reference Only)</th>
<th>Ra Micro-Inch</th>
<th>Ra Micro-Meter</th>
<th>RMS Micro-Inch</th>
<th>RMS Micro-Meter</th>
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<tbody>
<tr>
<td>150</td>
<td>27 - 32</td>
<td>0.68 - 0.80</td>
<td>30 - 35</td>
<td>0.76 - 0.89</td>
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<tr>
<td>180</td>
<td>16 - 23</td>
<td>0.46 - 0.58</td>
<td>20 - 25</td>
<td>0.51 - 0.64</td>
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<tr>
<td>240</td>
<td>14 - 18</td>
<td>0.34 - 0.46</td>
<td>15 - 20</td>
<td>0.38 - 0.51</td>
</tr>
<tr>
<td>320</td>
<td>8 - 10</td>
<td>0.21 - 0.25</td>
<td>9 - 11</td>
<td>0.23 - 0.28</td>
</tr>
</tbody>
</table>

- 3-A requires Ra 32µ-Inch or better.
- For purified water systems: Ra of 15 µinch is typically required

Ra is the Roughness Average, after Polishing. Ra is usually expressed in Micro-Inch (u-inch) or Micro-Meters (Microns).
- Surface final finish is sometimes measured in Roughness RMS (Root Mean Squared). Micro-inches x 1.11 = roughness RMS.
Cracks and Crevices

- Static seals shall be cleanable and drainable with minimum crevices, gaps, and horizontal surfaces
- O-rings shall be flush with pipe wall and be self-aligning and self-positioning
- EHEDG study shows that protrusion of less than 2mm (1/12”) is not cleanable
- Seals must be resistant to CIP solutions and tolerate SIP temperatures
- Dead Ends
  - Rule of thumb: diameter 2 times larger than depth
  - Use Instrument Tee or short outlet Tee to improve cleaning

Example: Tank fitting
Self draining

- Self draining design of pipes and tanks is a must.
- Pipe runs must have minimum pitch of 1/4” per foot.
- Gravity draining must be in the direction of the designated drain and away from spray balls.
- No dead spaces or dead leg designs.

Dead Ends

Unacceptable

Acceptable

Examples of positions difficult to clean in a pipe system.
Velocity and volume

Mechanical action – flow velocity

• Lines - Flow Rate
  • Turbulent Flow - Min. 5 ft. per sec.
  • Large Lines - 8 to 10 ft. per sec.

• Tanks - Flow Rate
  • Horizontal - 0.12 - 0.30 gpm per sq. ft.
  • Vertical - 2.5 - 3.5 gpm per ft. of Circumference

Magnetic flow meter – best way to ensure correct velocity
Tri-Clamp (DIN 32676/ISO 2852)

Instruments mounted in-line should preferably use Short outlet or Instrument Tee to minimize dead legs.
Impact of dead legs

In-line process connections (e.g. Variline housing) can have a ROI of a few days!

Source:
„Einsparpotentiale bei der CIP-Reinigung von Produktionsanlagen durch konsequentes Hygienic Design“;
The Tri-clamp connection is common in the food industry and was originated and designed by the company Tri-clover.
The sensors can either be placed at tanks or in pipes. The advantage of that system is the easy installation of the sensors.
The parts of the clamp system are put together via clamps. 
Pressure rated to 600psi with standard clamp (1000psi with high pressure clamp) up to 2“ only

Sizes from ½“ to 6“

½“ + ¾“ – same clamp
1“ + 1-1/2“ – same clamp

Pay attention when selecting clamp option; there are ISO, DIN std and Tri-Clamp. Style is not critical for “dead end” connections such as for pressure, temperature but is critical for “flow-through”. The ID is slightly different that can cause cleaning problems
DIN 11851, DIN 11864 and SMS

DIN 11851 (Milk Coupling)
Older European std. Being slowly phased out by 11864

DIN 11864 Aseptic Coupling
Very good sanitary seal design
Watch out – there are 3 styles and 3 different tube ID’s

SMS coupling
Common in Scandinavia and France
Tuchenhagen Varivent

The Varivent - Inline housing must be used together with a Varivent flange. With the inline housing a sanitary flush mounting is reached. The Varivent parts are held together with a clamp.
Flush mounted Weld fittings

• Endress+Hauser offers weld fittings to provide sanitary flush connections of several products

- **Weld spud for Deltapilot S**
- **NA Connect – Tri-Clamp compatible weld fitting – Shown here when used with radar unit**
- **Weld spud for point level and other instruments**
Cleaning of Processing equipment

Sanitation 4 x 4

• Step 1. Pre-Rinse
• Step 2. Wash - Remove Soil
  • Concentration of detergent (abt 2%)
  • Temperature of wash and rinse fluid (above 140F)
  • Time of cleaning (typical 20 to 45 min)
  • Mechanical Action – Flow velocity 5-10ft/sec (turbulent flow)
• Step 3. Rinse / Inspect
• Step 4. Sanitize – Kill Microorganisms
Product Loss Reduction - Effective phase separation milk / water

- OUSAF11 Optical sensor

- Conductivity
- Optical density

100% water 100% milk/cream
Sensitivity comparison OUSAF11 vs Anderson ITM-3

Milk (3.5%) in Water

- Milk (3.5%) was added to water. Concentration values in % are given in volume to volume milk in water.
- For comparison the AU Units of OUSAF11 were calculated into %

High sensitivity of OUSAF11 at low concentrations of milk
OUSAF11 optical density sensor

- Glass-free and hygienic sensor for Food applications
Control of the CIP system (Clean in Place)

- Overflow protection with Liquiphant M
- Conductivity measurement with CLS54D
- Level measurement with FMB50
- Sanitizer solution
- Conductivity measurement in return line with CLS54D
- Flow measurement with Promag H
- Make-up water
- CIP-Return flow 1
- CIP-Return flow 2
- To heat exchanger
- CIP-line 1
- CIP-line 2
- Acid
- Caustic
- Water
- Overflow protection with Liquiphant M
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Detergent Feed (Dosing)

- Timed - Continuous / Pulsed
- Conductivity Controlled (concentration)
- Injection Feed
  - Manifold
  - Chemical Loop
- Atmospheric Feed
- Cleaners (Sodium Hydroxide, Phosphoric acid, Citric acid or enzyme based.
- Sanitizers (chlorine, Para acetic acid PAA, quaternary ammonia, Hydrogen Peroxide, Iodophor, Steam, boiling water …)
CIP – chemical concentration- best practices

- Concentration measurement of return lines
  - Ensures whole loop is up to concentration (maximized cleaning)
  - Reduces chemical usage and cleaning time
    - Less energy used
    - Less detergent used
    - Less water used (=less water treatment needed)
- Concentration measurement of make-up tanks
  - Ensure starting point is correct
  - Optimizes use of detergent (eliminate manual over/under dosing)
Conductivity measurement - options

Compact Instrumentation

Food & Beverage industry
- Simple CIP application
- Phase separation
- Product monitoring
- Fit for purpose
- Just measuring
- MR switch (2MR)
- No controller function
- Good value for money

Food & Beverage industry, Pharmaceutical industry
- CIP application
- Phase separation
- SIP application
- Product monitoring
- Exact measurement
- Digital sensor
- MR switch
- Concentration display
- Dual sensor & more
- Self-monitoring
- Memobase Plus

Food & Beverage industry, Pharmaceutical industry
- CIP application
- Phase separation
- SIP application
- Product monitoring
- Exact measurement
- Digital sensor
- MR switch
- Concentration display
- 4 up to 8 sensors
- Self-monitoring
- Good value for money
- Memobase Plus
Compact, CIP concentration conductivity sensor CLD18

The new generation of toroidal compact instruments

- Small stainless steel or plastic housing
- IP69k
- Small toroidal sensor
- PEEK material
- All major food process connections
- Made for use in food & beverage industry
CM44x Flexible Customizable for Individual Demands

- Up to 8 Digital Memosens sensor inputs
- Customer saving of up to $800 in labor compared to 8x conventional panel mounted transmitters.
- Analog 0/4..20mA and digital out- & inputs

(Q1 / 2014)

Ola Wesstrom
Other critical measurement points

- Flow velocity (volume flow) to ensure scrubbing action as well as sufficient volume for tank cleaning.
  - Ideal meter is the Promag H100 – optional temperature and conductivity output (4-20mA or Ethernet I/P)

- Temperature on return line – TSM 470 – 2 second response time
- Level of supply tanks – Capacitance or Hydrostatic level
- Level in storage tanks - Ultrasonic
- Phase separation to minimize losses – Optical OUSAF11
- Record keeping – RSG35 or RSG 40
FSMA and SQF impact

To be in compliance with FSMA (Food Safety Manufacturing Act) the cleaning procedures need to be documented and verified (example SQF certification – Safe Quality Food)

SQF Wording: Documented Cleaning Methods

11.2.13 Cleaning and Sanitation
11.2.13.1 The methods and responsibility for the cleaning of the food handling and processing equipment and environment, storage areas, staff amenities and toilet facilities shall be documented and implemented. Consideration shall be given to:

i. What is to be cleaned;
ii. How it is to be cleaned;
iii. When it is to be cleaned;
iv. Who is responsible for the cleaning;

v. Methods used to confirm the correct concentrations of detergents and sanitizers, and

vi. The responsibility and methods used to verify the effectiveness of the cleaning and sanitation program.
Installation examples

Measuring concentration in make-up tanks or dosing

Level measurement of detergent storage tanks

CIP return/supply lines with instrumentation
Wash Down

WANTED

Killer of 1000’s of instruments
$10,000 Reward
not rounding up that dirty lowdown nutter gremlinger.

Foaming cleaners
Wash Down

Protect Your investment - Suggestions

• Drip Loops/electrical connections pointing down
• Avoid conduits all the way to instrument – use sealed cable entries – example M20
• Sealed Quick Disconnects
• Use remote option
• Use fully welded/sealed instruments where possible
• IP and NEMA ratings – Look for IP67/Nema6 or higher

Moisture absorbing material – not very useful

High pressure washdown IP69K
Tank Cleaning Equipment

Courtesy of Trueclean and CSI

www.trueclean.us
www.csidesigns.com
Tank Cleaning Methods

Manual
A worker physically cleans a tank and may need to actually enter the tank to do so.
• Safety concerns:
  • Tank entry/exit
  • Exposure to toxic fumes
• Inconsistent cleaning
• More cleaning chemicals and/or water are required

Fill and Drain
Tanks are usually hosed down and then filled with hot water or a mix of water and cleaning agents.
• Time consuming
• Uses significant amounts of water, cleaning chemicals, and energy
• Tank is out of production for several hours

Automated Cleaning
Many plants find they can save tens of thousands of dollars annually by automating their tank cleaning process. Facilities with several tanks have reported savings of more than $100,000 per year. Determining if you could benefit similarly through automation begins with a close look at your cleaning objectives.
Example: savings with automated system

<table>
<thead>
<tr>
<th>Annual</th>
<th>Manual Scrub / Washdown</th>
<th>Fill &amp; Drain</th>
<th>Automated System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production downtime cost*</td>
<td>$50,000</td>
<td>$25,000</td>
<td>$10,000</td>
</tr>
<tr>
<td>Labor cost†</td>
<td>$12,000</td>
<td>$6,250</td>
<td>$1,250</td>
</tr>
<tr>
<td>Total cost**</td>
<td>$62,000</td>
<td>$31,000</td>
<td>$11,250</td>
</tr>
</tbody>
</table>

* Downtime estimated at $100/hour (Labor estimated at $25/hour)
† Based on average of 250 washes/yr of 1500 gallon (5600 liter) tank
** Based on average of 250 washes/yr of 1500 gallon (5600 liter) tank

Estimated Annual Savings .......... $50,750
**Example Wash Patterns**

### Sprayball
- **Chemical**
  - Pressure: 1.0-2.5 bar
  - Mix: 90% chemical, 10% mechanical

### Rotating
- **Chemical/Mechanical**
  - Pressure: 0.5-20 bar
  - Mix: 50% chemical, 50% mechanical

### Orbital
- **Mechanical/Chemical**
  - Pressure: 2-90 bar
  - Mix: 20% chemical, 80% mechanical

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02/10/2015

Endress+Hauser
Comparison- Static vs. rotating spray ball

<table>
<thead>
<tr>
<th>Tank Diameter [ft]</th>
<th>Static Spray Device</th>
<th>Rotating S Range</th>
<th>Time Saving</th>
<th>Possible Time Reducing Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – 4</td>
<td>3/8</td>
<td>14</td>
<td>9</td>
<td>S20</td>
</tr>
<tr>
<td>3 – 5</td>
<td>3/4</td>
<td>14</td>
<td>18</td>
<td>S30</td>
</tr>
<tr>
<td>6 – 10</td>
<td>1</td>
<td>14</td>
<td>48</td>
<td>S40</td>
</tr>
<tr>
<td>10 – 13</td>
<td>1</td>
<td>36</td>
<td>124</td>
<td>40HF</td>
</tr>
<tr>
<td>13 – 17</td>
<td>2</td>
<td>36</td>
<td>184</td>
<td>S50</td>
</tr>
</tbody>
</table>

Comparison using spray patterns of 360°
Case Study: S50 rotating spray ball

Facility conditions

• A brewery retrofitted S50 spray device for cleaning fermentation tanks.

• Tanks have capacity of 185,000 gal, 82 ft (height), 20 ft (diameter).
Savings from S50

• 34% reduced CIP time
• 58% reduced fresh water consumption
• 39% reduced consumption of lye
• 11% reduced consumption of acid
• 58% less waste water
Thank you very much for your attention