WORLD BREWING CONGRESS
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#ElevateBeer

BREW KETTLE CLEANING

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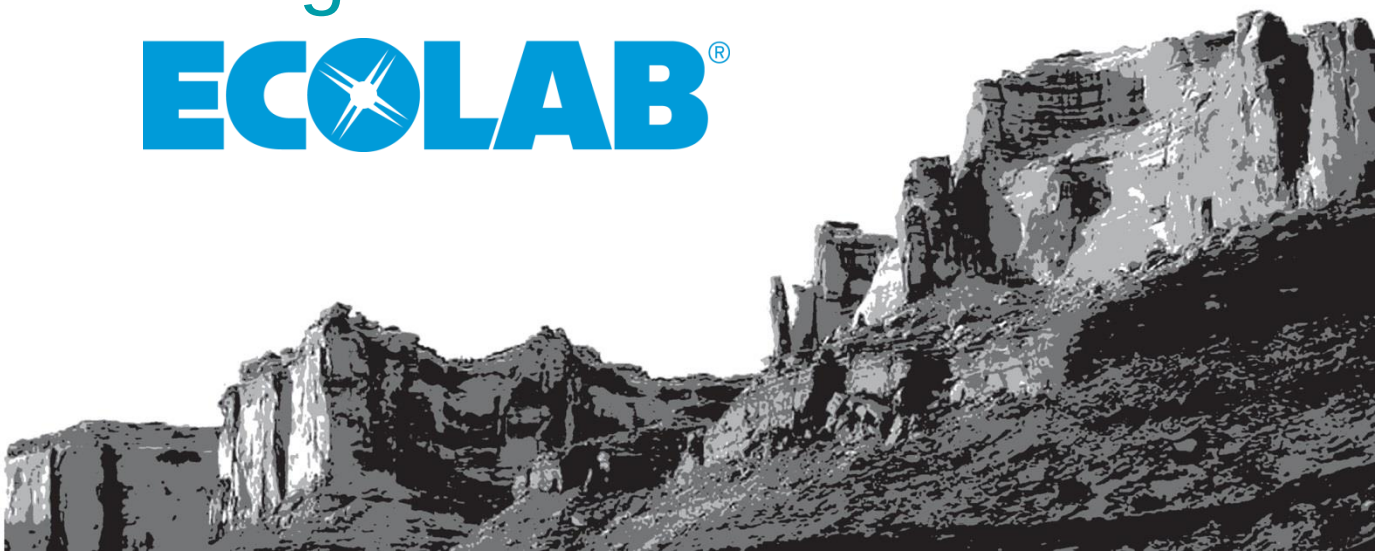

AGENDA

- Safety Moment
- Sanitation Process
  - 4x4 Cleaning Model
  - Typical recipe
- Soil Types
- Kettle Soil Examples
- Chemistry
  - Match cleaner to soil
  - Pros & cons
  - Additive program
- Equipment
- Calandria Example
- CIP Verification

SAFETY MOMENT

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- When performing any tasks with chemicals proper PPE is essential
- Signage should be used to communicate that a cleaning process is occurring
- Safeguards should be used to keep manways and ports from exposing workers, visitors and tours to hazards such as temperature extremes and cleaning solutions

SANITATION PROCESS BASICS

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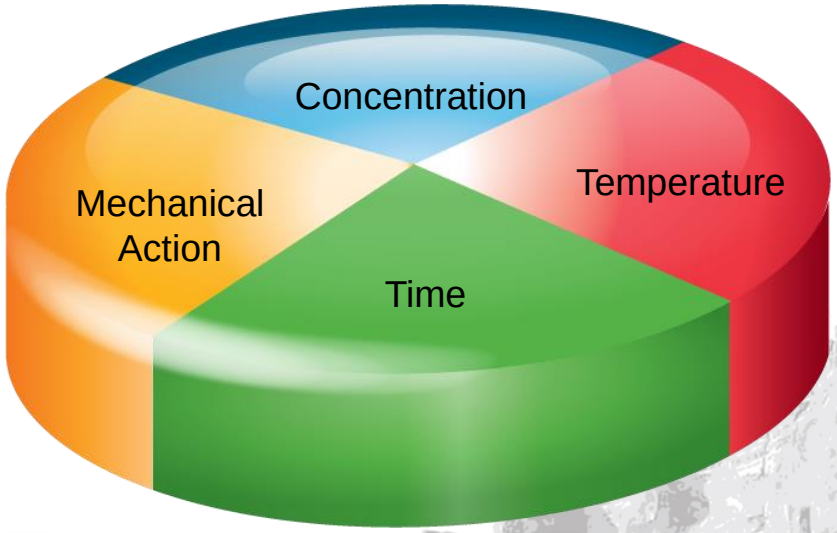
4X4 Sanitation process applies to all methods of cleaning:

Four Basic Steps to Sanitation:

1. Pre-Rinse
2. Clean (Wash)
3. Rinse & Inspect
4. Sanitize

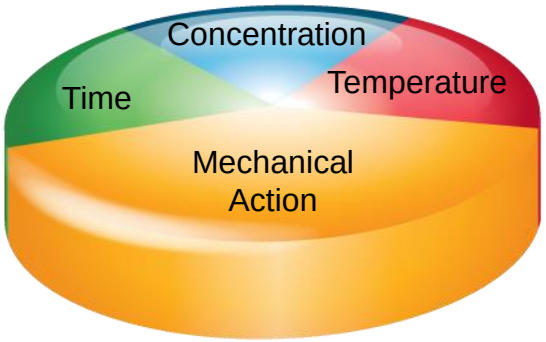
Four Factors of Effective Cleaning:



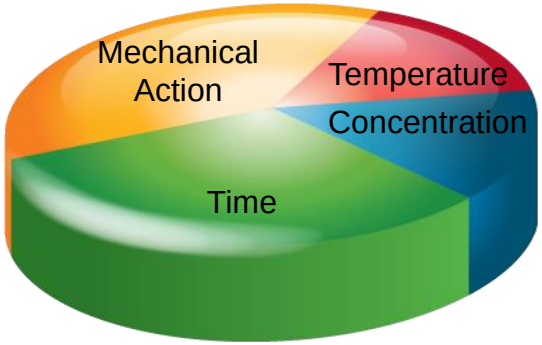
4 X 4

SANITATION PROCESS BASICS

Impact of each cleaning factor varies with cleaning method:

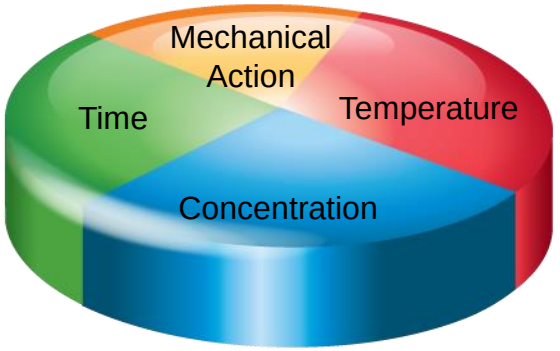


Manual (Hand) Cleaning



Foam Cleaning

Brew Kettle



CIP Cleaning

TYPICAL WASH RECIPE

- Pre-rinse with hot water
- Circulate 3-5% active caustic solution at 60-75°C (140-170°F) for 45-60 minutes
- Rinse with ambient water to makeup water pH
- Periodically, an acid rinse if scale is present
- Inspect

SOIL TYPES

COMMON BREW KETTLE SOILS

ORGANIC	INORGANIC
• Protein • Carbohydrates • Oil & Grease	• Water Hardness Scale • Iron, manganese, other metallic deposits

• Heated tanks and circuits in the brewhouse create heat-hardened/burned-on soils:
  • Carbohydrates and sugars from brewing ingredients
  • Protein precipitation/trub
	• Mineral Scale Formation:
	  • Calcium Hydroxide
	  • Results from sodium hydroxide reacting with hard water (calcium or magnesium bicarbonate)
	  • Beer Stone:
	  • Calcium Oxalate from the brewing process

KETTLE ORGANIC SOILS

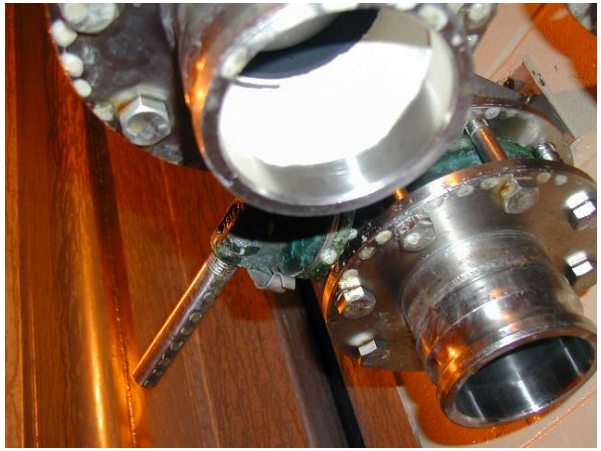
- Organic soil typically appears a dull brown color
  - Can have a rainbow hue, depending on amount of protein residual
- Wort boiling in the brew kettle creates highest level of heat-hardened soil
  - Calandria challenging to clean
- Amount of soil – and difficulty removing -- depends on specific beer, brewing process and the number of brews between cleaning



KETTLE INORGANIC SOILS

Calcium Carbonate

"pure" scale in hot water line



Calcium carbonate

In beer transfer line. Color related to beer ingredients

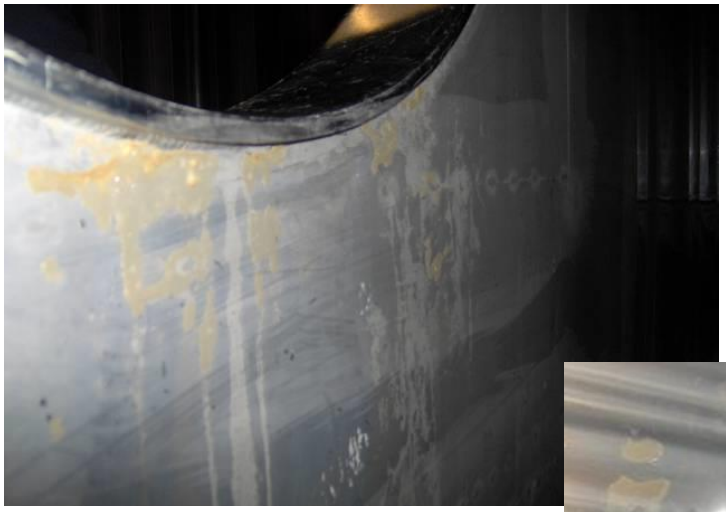
"Dry" calcium/ magnesium carbonate

"Wet" calcium/ magnesium carbonate

BREWHOUSE INORGANIC SOILS

"Beer Stone":

- A combination inorganic soils from both beer and water.
- Predominantly calcium oxalate plus organic components and minerals.



KETTLE SOIL EXAMPLES

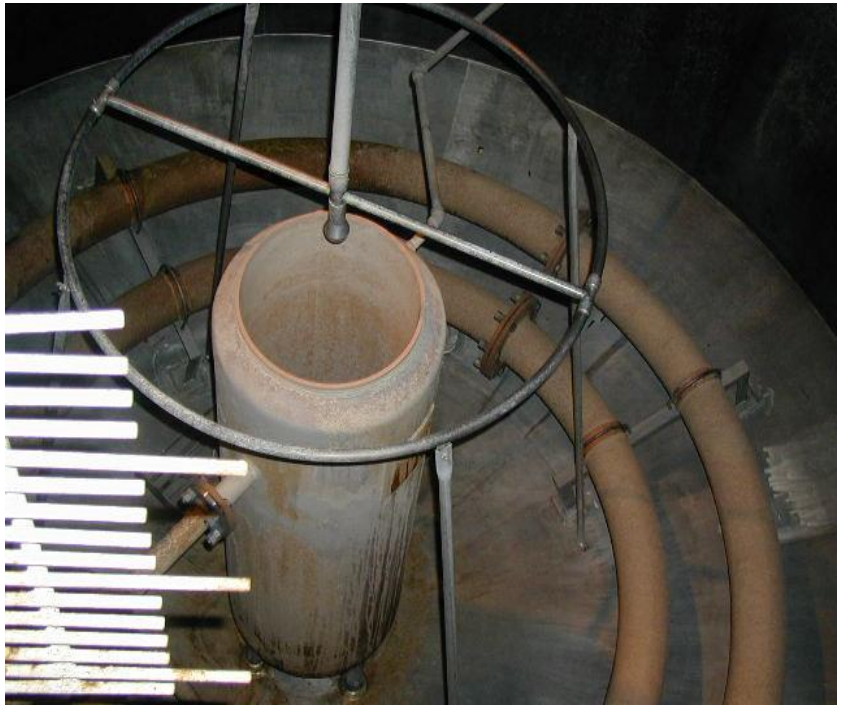
BREW KETTLE SOIL - EXAMPLES

- Heat hardened soil
- Heavy concentration of starch and protein
- Brown or rainbow appearance

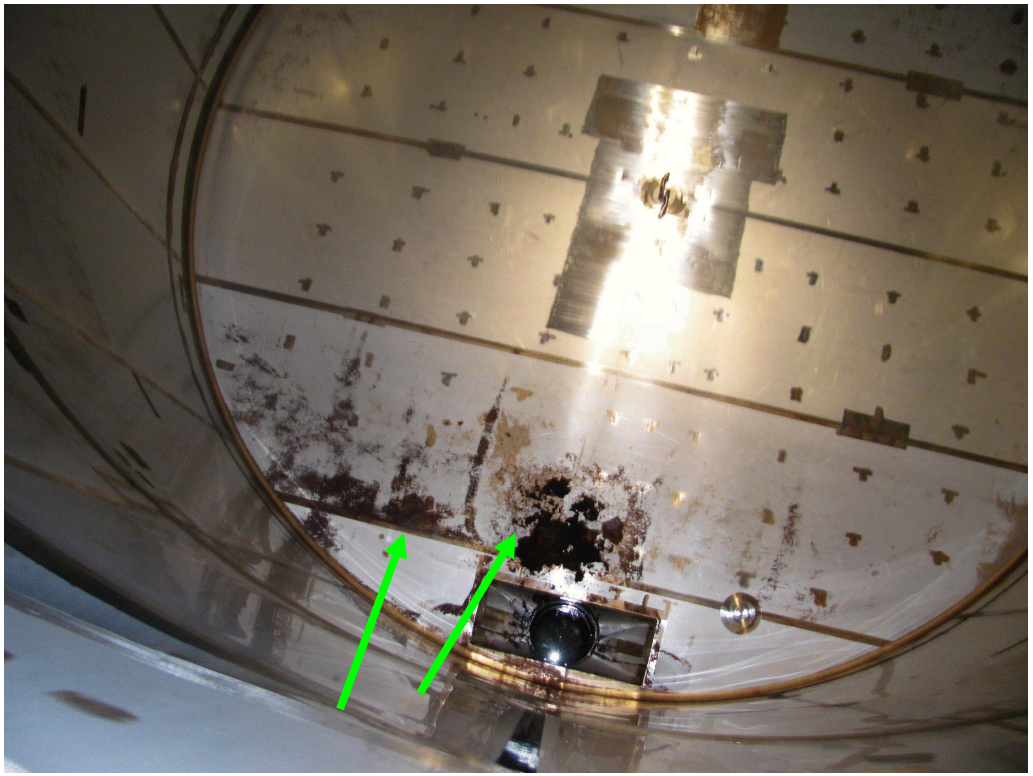
COMPLEX PROTEIN/CARBOHYDRATE

BAFFLES & SHADOWING EFFECT

TUBES/COILS & SHADOWING

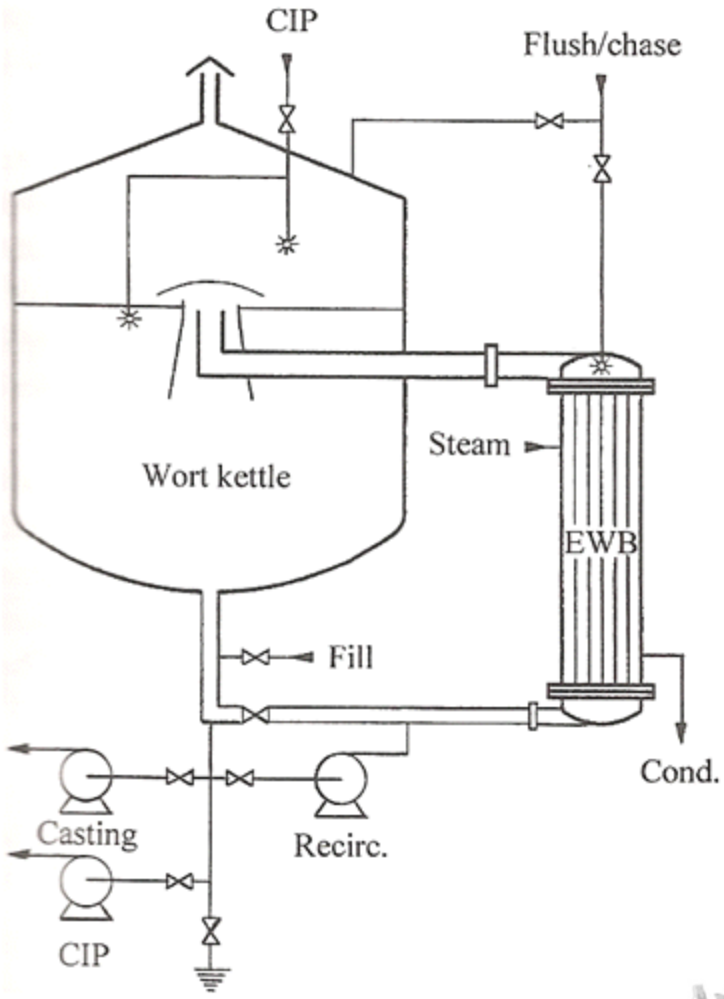


BREW KETTLE EXAMPLE



Pooling in bottom of tank by drain reduces impingement of cleaning solution

KETTLE AND CALANDRIA



BREW KETTLE - CALANDRIA HEAT-HARDENED SOIL

BREW KETTLE - CALANDRIA HEAT-HARDENED SOIL

CHEMISTRY FOR SOILS

MATCH CLEANERS TO SOIL

ORGANIC SOILS	INORGANIC SOILS
• Protein • Carbohydrates • Oil & Grease	• Water Hardness Scale • Iron, manganese, other metallic deposits
ALKALINE CLEANERS	**ACID CLEANERS**

MATCH CLEANER TO SOIL

Alkaline Cleaners are used regularly and are most effective at dissolving or dispersing organic soils

Alkaline Cleaners:

- Solution with pH >7
- Dissolves/Disperses Organic Soils
- Common Sources:
  - Caustic soda NaOH
  - Caustic potash KOH
  - Silicates
- Technical Data Sheet lists strength as $\%Na_2O$

Acid Cleaners are used periodically and are most effective at dissolving inorganic soils:

Acid Cleaners:

- Solution with pH <7
- Dissolve mineral soils
- Mineral Acids: Phosphoric (H_3PO_4), Nitric (HNO_3), Sulfuric (H_2SO_4)
- Organic Acids: Citric, Hydroxyacetic, Methane-Sulfonic

PROS & CONS

What are the Pros & Cons of each category of cleaner as it pertains to the brew kettle?

ALKALINE CLEANERS	ACID CLEANERS

• Pros
  • Proven
  • Effective
  • Compatible with oxidative additives
	• Pros
	  • Effective at removing beer stone
	  • Rinses easily from kettle

• Cons
  • Scale formation if not built
  • Higher concentrations not easily rinsed
  • Compatibility (if highly built)
	• Cons
	  • Not compatible with sodium hypochlorite
	  • Many not compatible with copper
	  • Very poor at removing organic soils

ADDITIVE PROGRAMS

Additives can be beneficial for the removal of heat hardened soils in a brew kettle.

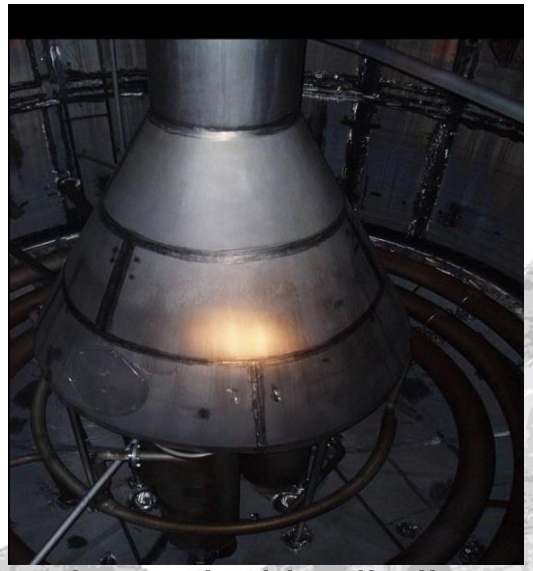
- Built Cleaners
  - Stabilizers/water conditioners (e.g. Sodium Gluconate)
  - Surfactants
  - Chelants (e.g. EDTA)

- Additive to a CIP wash solution
  - Hydrogen Peroxide (H2O2) – Example on next slide
  - Sodium Hypochlorite (Chlorine)
  - Peracid Overide
  - Chelants (e.g. EDTA)

ADDITIVE PROGRAM EXAMPLE

- For heat-hardened protein in Brew Kettle heating stack
  - Alkaline followed by Acid Rinse leaves soil residues, despite 5-step process
  - Alkaline cleaner plus oxidizer delivers superior results in fewer steps (3)

Cleaned with Alkaline followed by Acid Rinse



Cleaned with Alkaline + Hydrogen Peroxide (oxidizer)

BREW KETTLE CONSIDERATIONS

- CIP Cleaning and caustic brew frequency guidelines:
  - No “rule of thumb” exists
  - Cleaning frequency is recipe, process and equipment-specific
    - Each unique brewery and brew leaves varied soils
  - Daily, weekly or after certain number of brews

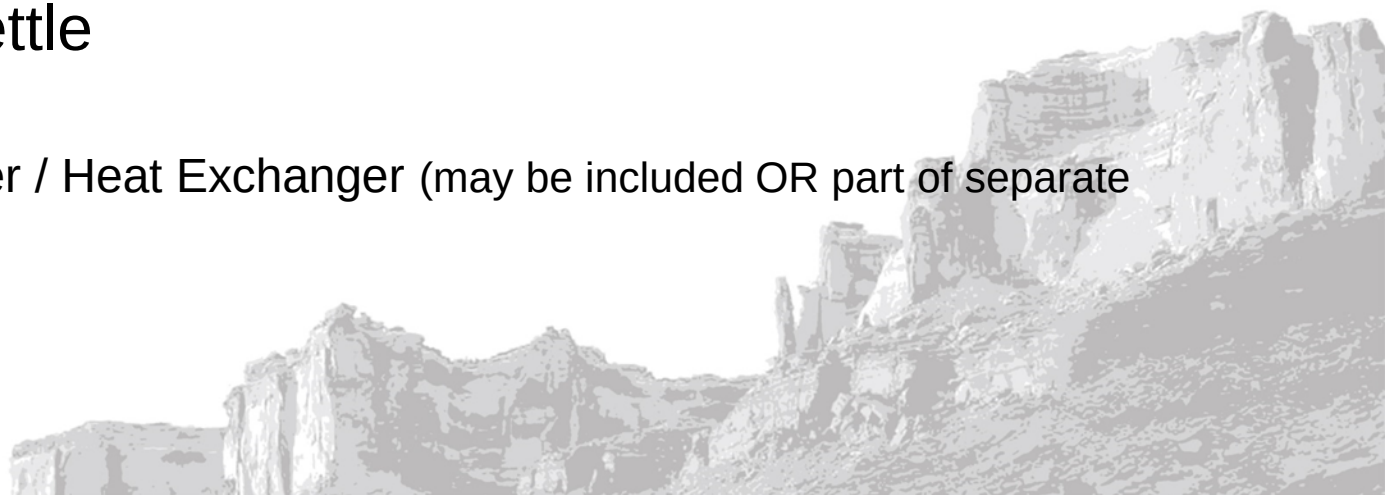
BREW KETTLE FREQUENCY

- Drivers for this frequency include but are not limited to:
  - Heat exchanger efficiency
  - Steam pressure / on jacket temperature
  - Soil build up in a calandria
  - Interaction from brew to brew
  - Next brew frequency
  - Consumer/production demand

CAUSTIC BREW

- A “Caustic Brew” uses chemistry which is passed through each vessel to the next and cleaning each as part of a CIP process.

- Vessels included in typical Brewhouse CIP circuit:
  - Cereal Cooker
  - Mash Tank
  - Lauter Tun
  - Brew Kettle
  - Whirlpool
  - Wort Cooler / Heat Exchanger (may be included OR part of separate CIP system)



CIP EQUIPMENT

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- Rinsing after caustic can be an issue particularly when using higher concentrations of caustic.
- Rinsing equipment varies by brewery design

- Rotating Spray Jets
- Spray balls
- Pig Tails
- Deluge Nozzles

BREW KETTLE CIP EQUIPMENT

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CIP EQUIPMENT

- Pros and Cons of each option to consider
  - Cost (Total Cost)
  - Kettle design
  - Effectiveness
  - Water use
  - Impingement
  - Location
  - Time

CALANDRIA EXAMPLE

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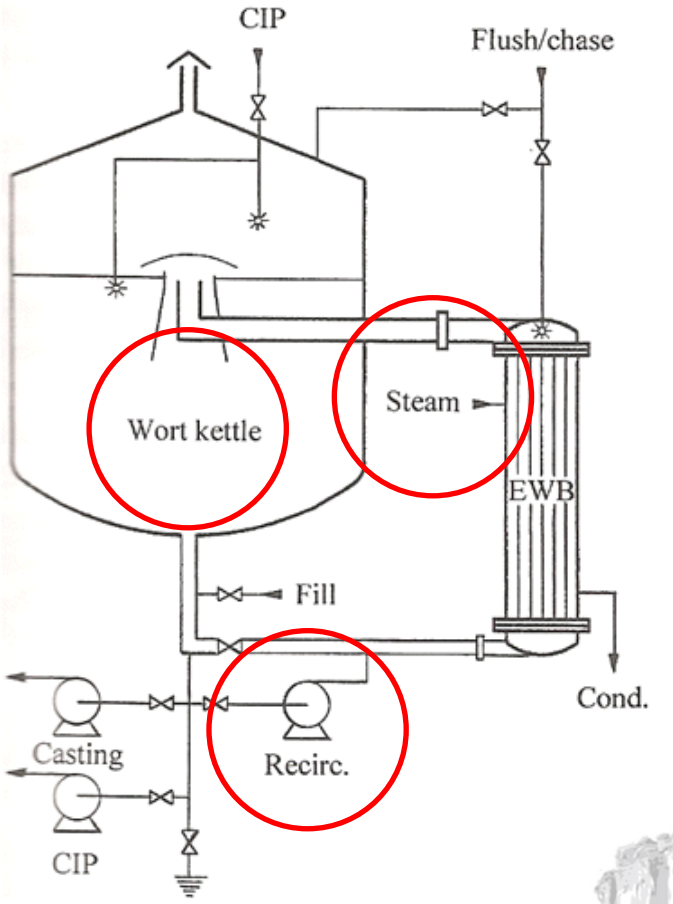
- Proper brewing process makes cleaning easier



Wort + Circulation + Steam =

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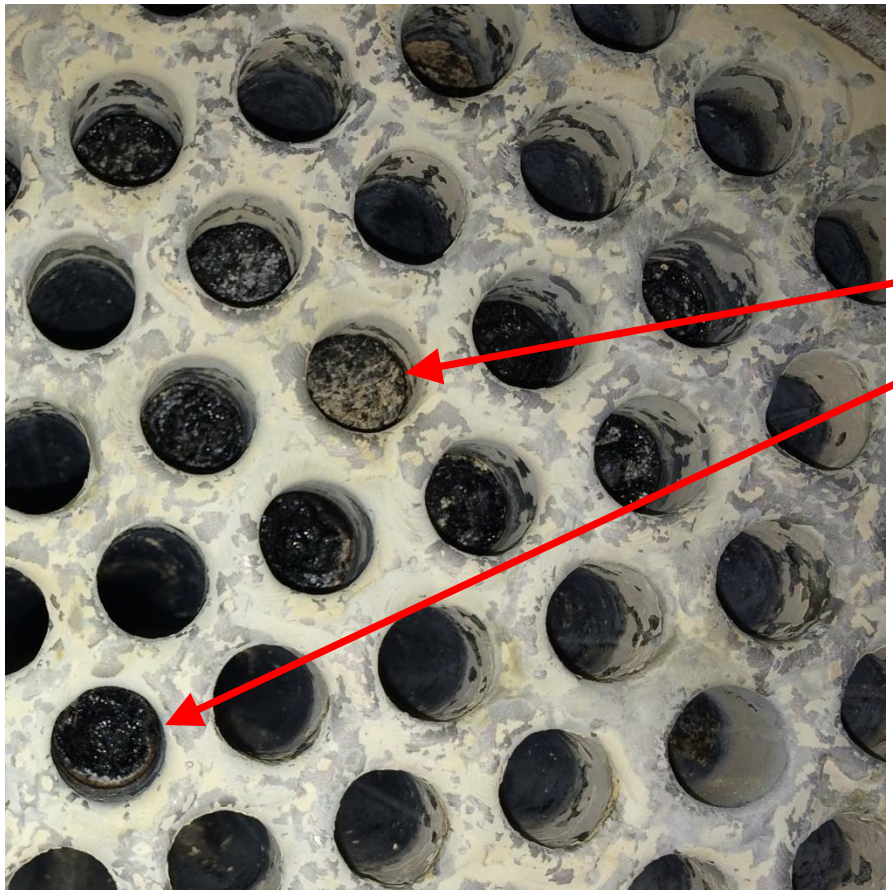
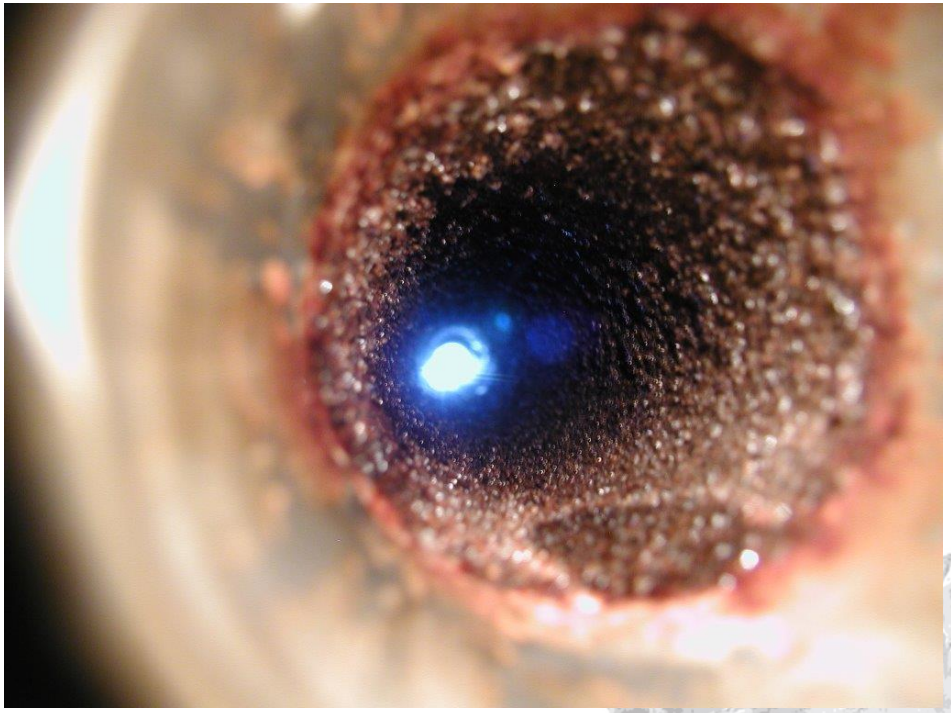
Circulation + Steam =

CALANDRIA EXAMPLE



Completely plugged tubes

ADDITIONAL CALANDRIA EXAMPLES



CIP VERIFICATION

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The Internet of Things (IOT) environment (“Big Data”) allows continuous CIP monitoring and reporting possibilities driving quality and efficiency.

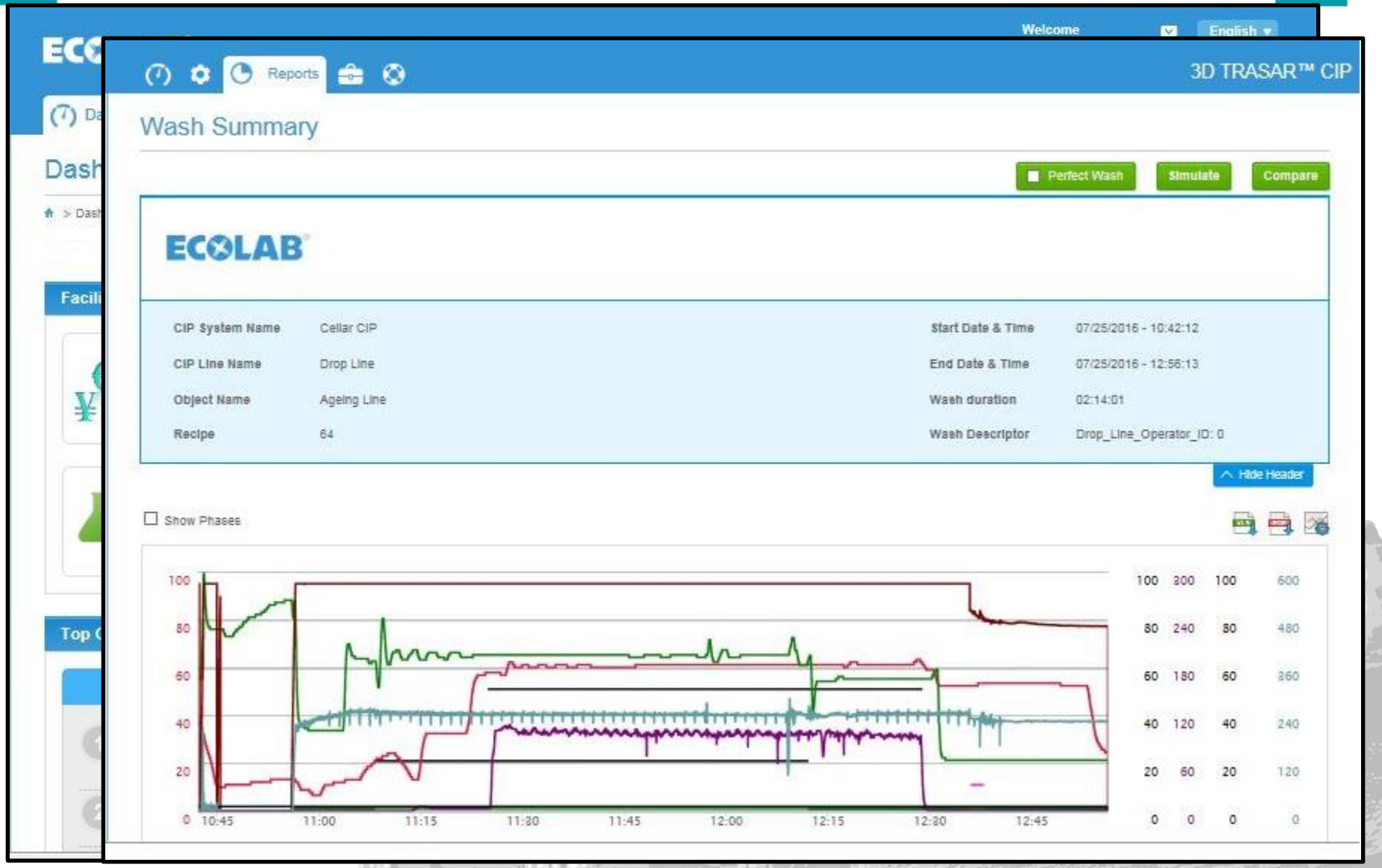
Recent innovations in CIP include:

- CIP verification software
- Remote analysis
- Web enabled reporting

Software monitors the CIP program/recipe and reports when pertinent criteria are not met.

- Flow
- Temperature
- Concentration
- Time

CIP VERIFICATION EXAMPLE



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Thank you!

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