Processing Time Length Extension Considerations – Fowling in Heat Exchangers

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Technical Innovation & Stewardship

Fowling is detrimental to heat exchanger performance and affects both heat transfer and pressure drop and therefore processing times.

Fouling is characterized by accumulation of unwanted deposits on heat exchanger surfaces and occurs through stages.

Fowling can occur on **product** or media sides.

Stages of Fowling

- Initiation
- Transport of fowling
- Adhesion of the deposits
- Transport of material away from surface
- Aging of the deposited

The rise of unconventional ingredients

Superfoods Trends

- Designer Dairy
- Kombucha
- Plant Based Protein; Almond, Oats, Soy
- Grab and Go, One and Done Meal Replacements
  - DHA, Probiotics, Fiber, Protein ???????
- Tiger nuts
- ??????

Characteristics of Fowling

Fowling material tends to have different characteristics than bulk fluid being processed.

- Chemical reaction with proteins
- Crystallizations of mineral salts
- Characteristic of batching water and sterile water has to be taken into account
- Complicated interactions between deposits and surface bonds

Must have understanding of structural elements of product.

Soils attach to the surface, combine and layer with other soils and are concentrated by UHT

Hard to Clean Soils

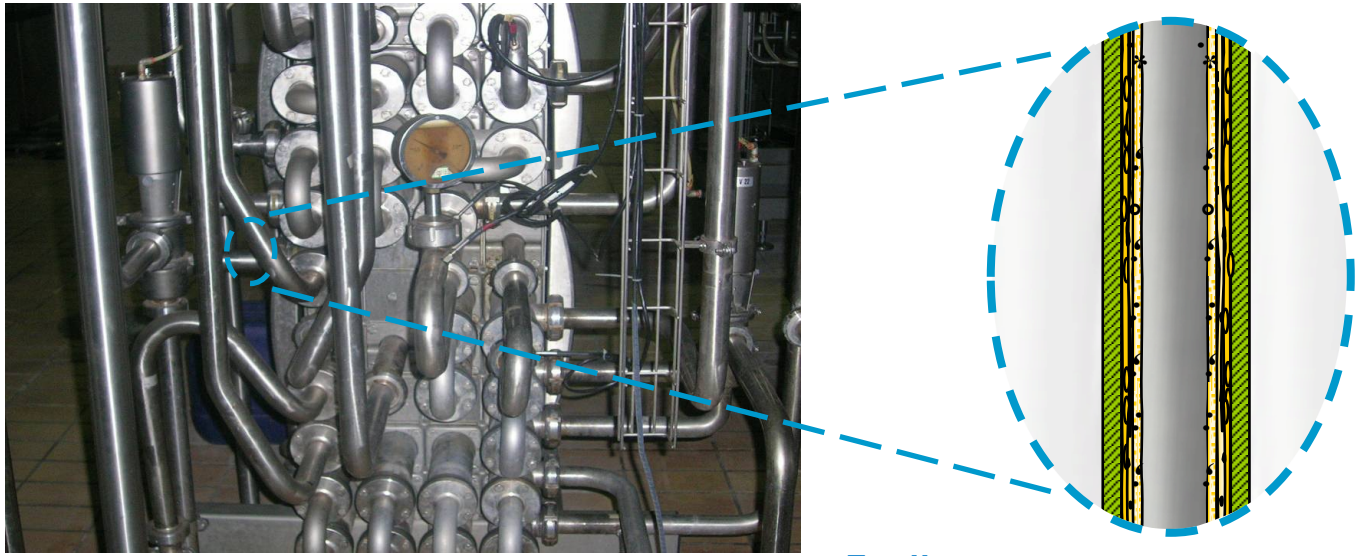
- Proteins
- Fats
- Oils
- Hardness – Minerals in product as well as ingredient water

Complex Carbohydrates

- Cellulose
- Starches
- Gums
- Monosaccharides
- Disaccharides

Application Overview
UHT Fouling Illustration

Click to Start



Fouling:

- Dense layer of mineral deposit formed on stainless
- 2nd layer formed consisting of matrix of proteins, fat, and/or carbohydrate depending on process stream

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AIC(Aseptic in Caustic) wash

Perform once every shift (or 8 hrs) - prevents buildup from getting too extreme. Less viscous products may be able to run longer on production but products such as protein and fat based drinks will need more frequent AIC washes.

Most runs are targeted for 48 hrs between full cleanups but can last up to 72 hrs with proper care.

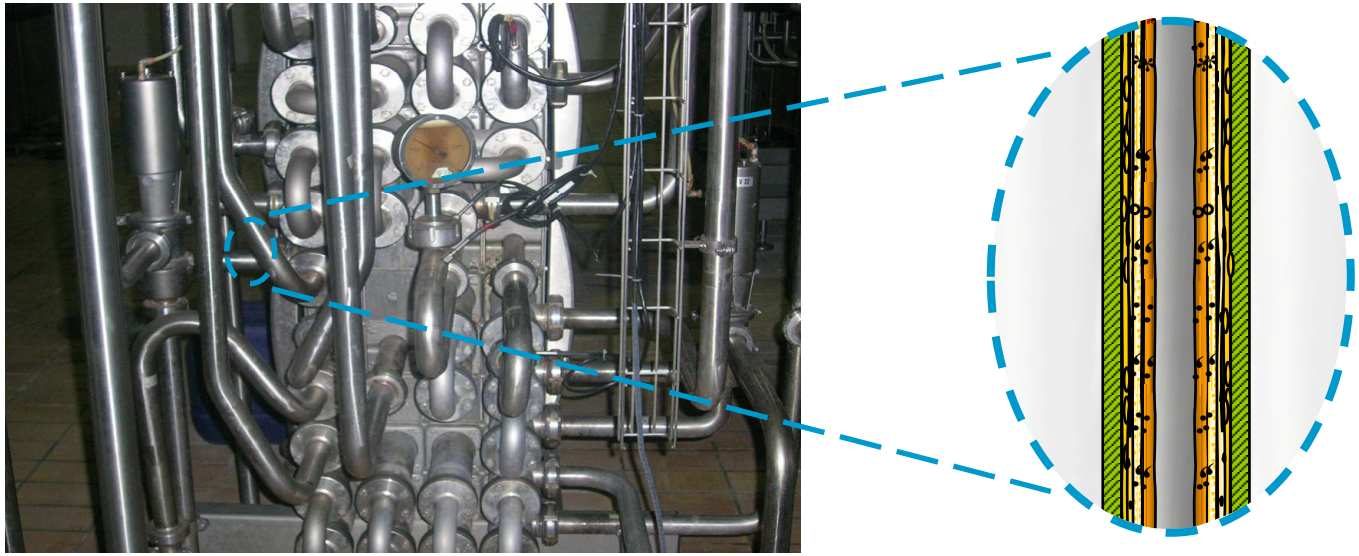
Do not circulate AIC caustic for more than 15 minutes before dumping

Keep caustic in the AIC to 1.5% or less.

Maintain sterility during the AIC

Application Overview
Traditional Cleaning Chemistry Illustration

Click to Continue



- High caustic concentrations can cause fouling layer to swell leading to the formation of a rubber-like top layer (protein), thus preventing further penetration of the alkaline cleaning solution into the soil layer.

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Regular cleanup - steam injection process only

Rinse, Caustic, Rinse, Acid, Rinse

The caustic wash should be a 2 part wash (60 mins total)

First part - 30 mins circulation / production flow and use 180-190F caustic temperature, going above 190F temp can cause changes to the stainless steel (black color formation), 2.5-3% caustic

2nd part - 30 mins circulation - increase flow to tolerance limit and decrease temperature to 170-180F/ allow concentration to drop to 2%/check frequently during the wash time and add more caustic to maintain.

The acid wash - 45-60 min

Maintain highest flow possible / 1.5-2% acid concentration/temperature no higher than 160F.

Override Cleaning

Over-ride procedure:

This technique is generally used for hard to clean products on equipment that requires a fast turnaround . Instead of separate acid wash and alkaline wash steps, the first step (acid step) is kept circulating while alkaline detergent is added to the required concentration. Although more detergent is used with this technique, since some must be added to neutralize the acid.

There is new override chemistry available, contact your chemical vendor.

Override Cleaning Continued

Step 1 - Pre-Rinse
Step 2 a - Wash – Acid
Step 2 b - Override (No Drain or Rinse)with Alkaline Detergent
Wash - Alkaline – Have to monitor temperature increase
Step 3 - Post-Rinse
Step 4 - Sanitize

Hygienic Design Defined

Hygienic Design is the application of design techniques which allow the timely and effective cleaning of the entire manufacturing asset.

Design Motivations;

Effectiveness & Efficiency of cleaning (must be considered in in the Design Validation stage)

Pathogen control

Micro and Insect Control

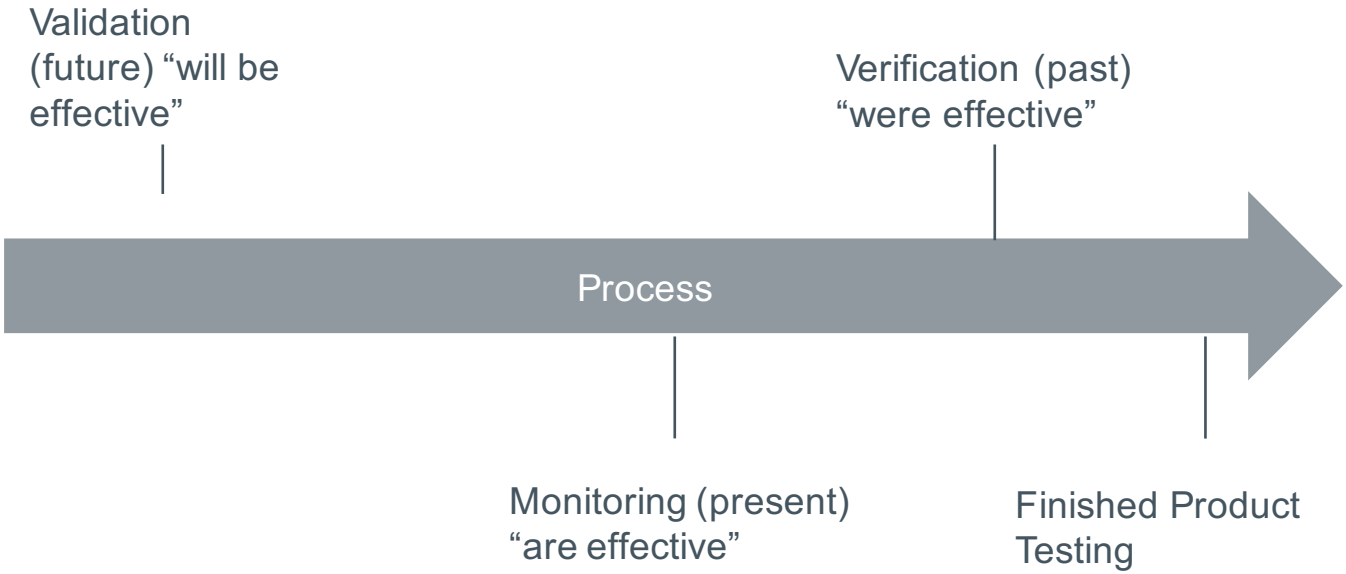
Allergen Control

Environmentally Friendly

Maintain the sanitary environment

Cost effective

Successfully over time produce a safe and quality product


Validation
(future) “will be
effective”
Verification (past)
“were effective”
Process
Monitoring (present)
“are effective”
Finished Product
Testing

Examples of Information Supporting Validation: Theoretical Proof Supporting Efficacy of Control Measures.

- **Scientific Community Challenge studies conducted by Corporate entity/service provider in a well-controlled environment**
- Peer-reviewed publications
- White papers
- **Equipment Manufacturers Manuals**
- Regulatory Authority References
  - Safe harbor documents
  - Guidance Documents on Hazards

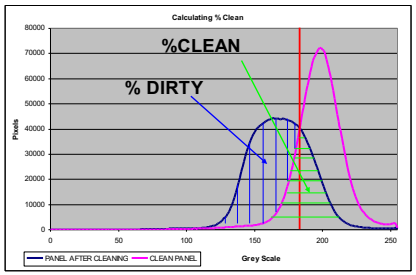
Examples of Information Supporting Validation: Theoretical Proof Supporting Efficacy of Control Measures.

Cleaning & Sanitation Product Provider

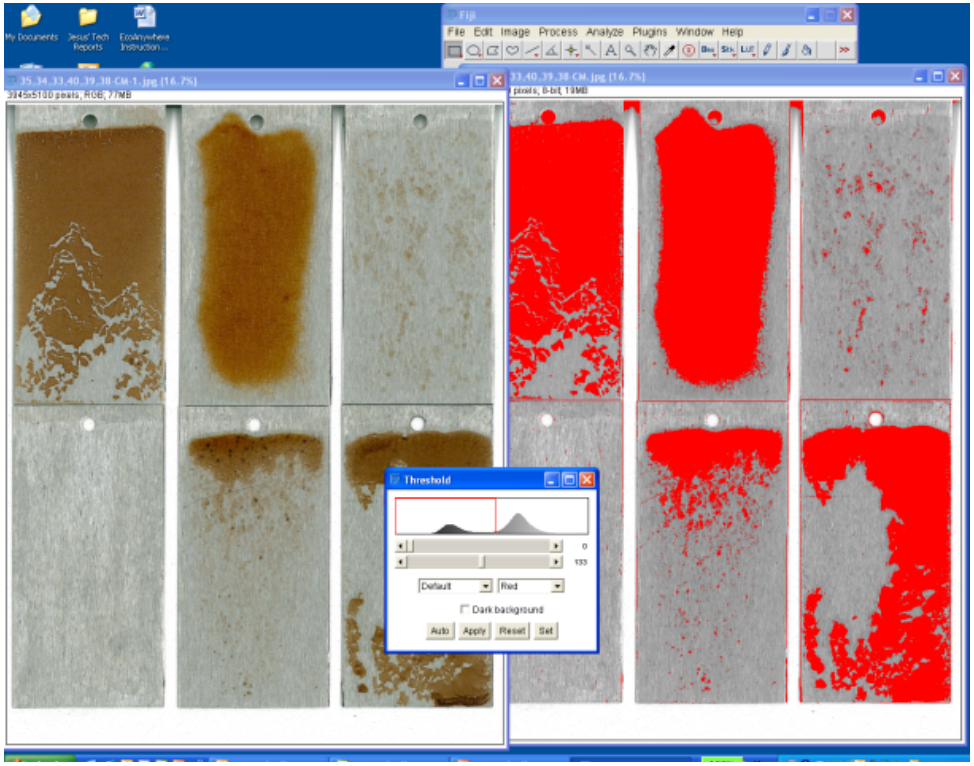
- Product Labels (e.g, EPA Registration information)
- **Catalog sheets**
- **Case studies/Cleaning Assessment**
  - **Justification that chemistry and chemical concentrations are appropriate for the soils in the application**
- Sell sheets, brochures
- Letters of Guaranty (LOG)
- Safety Data Sheets (SDS)

Quantitative Analysis

- %Clean by Image Analysis
- Possible Methods:
  - Subtraction



  - Threshold →
  - Weighted Total
- %Soil Removal



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Degree of Design Validation Required

Product, Process, Environment

- Level of hygienic design based on level of risk – product sensitivity
- Initial run times set in SSOP based on best available information collected during DV
- Based on product type standards – 3A, AMI, or EHEDG and facility design checklists

Hygienic Design Team

- Regardless of project type all projects need a starting point
- No one person has all of the needed knowledge or knows what questions to ask
- A cross functional team is critical to design success with at least one person with training and experience in hygienic design

Who to Include in Design Validation for Sanitation

Sanitarian or Sanitation Lead trained in hygienic design

Chemical Vendor Account Manager and/or R&D

Equipment Manufacturer

Sanitation Supervisor & Team Leader

Engineering

Quality

Safety

Maintenance

Product Development and Commercialization

Sanitation Controls

Sanitation Standard Operating Procedures:

- Very specific to the construction of the equipment
- Take into account the nature of the food
- The physical characteristic of the water used
- The concentration of cleaning and sanitizing chemicals
- The method of application, COP, CIP & Manual
- The cleaning and sanitizing intervals, frequency
- Flow, Time, Pressure, Temperature

Summary

Initial run times set in SSOP based on best available information collected during DV

No one person has all of the needed knowledge or knows what questions to ask – use of cross functional teams

Test run times and fowling characteristics on pilot lines or on product lines during trails using worst case scenarios.

General roll of thumb is start with 8 hours and make use of Aseptic in Caustic flushes, expand using 8 hours increments

Thank you.