WHITE PAPER

The Role of Manual Cleaning in Biofilm Prevention and Removal

INTRODUCTION:

Biofilms are a serious food safety threat because they are capable of harbouring pathogens and forming on many surfaces found throughout food manufacturing facilities. Biofilms also protect pathogens from chemicals and environmental stresses, allowing the microorganisms within them to survive for longer periods of time and to spread at unpredictable rates. Because of these factors, having an effective strategy to prevent and remove biofilms requires appropriate cleaning tools and methods.

Understanding Biofilms in the Food Industry

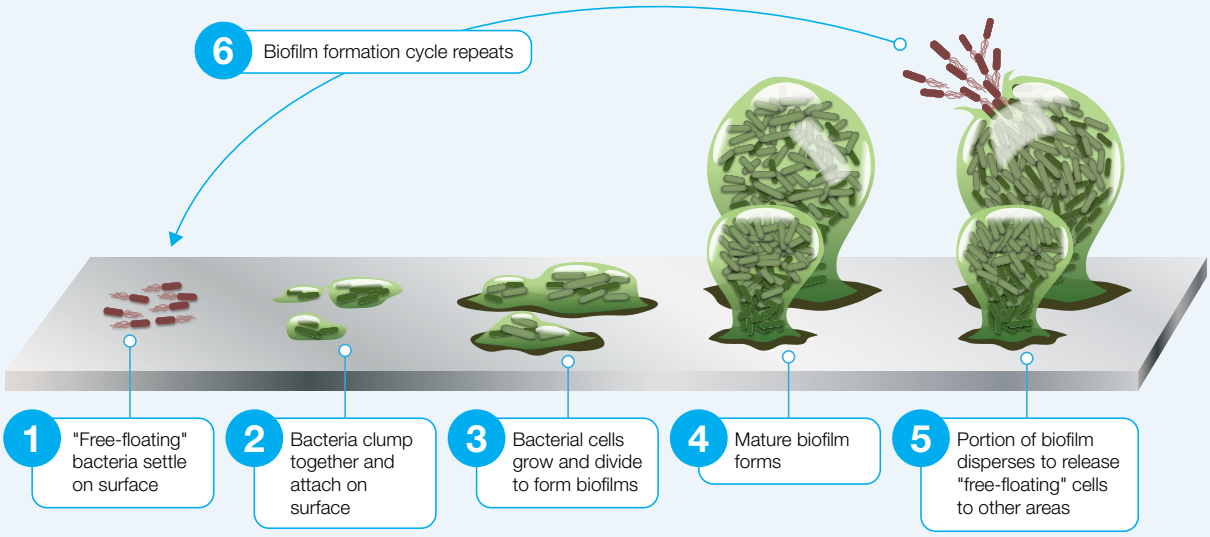
Listeria monocytogenes, Salmonella, Shiga-toxin producing *E. coli, Campylobacter jejuni,* and *Staphylococcus aureus* are among the key causative agents behind many illnesses and deaths associated with contaminated food. Although the microbial composition of a biofilm will vary, dependent on the environmental conditions, the most common pathogens listed above are all known to create and thrive in biofilms.

Some biofilms are relatively simple and others more complex, but they are all composed of three basic elements – microorganisms, nutrients, and water. When these three elements are left undisturbed over time, the microorganisms secrete an extracellular polymeric substance (EPS), or "slime", that is composed of polysaccharides, nucleic acids, and glycoproteins. This slime coating helps protect microbes from chemicals and environmental stresses and further anchors the microbes to the surface.

Microbes in a biofilm can be up to 3,000 times[1] more resistant to disinfectants than 'free floating' cells and they are able to survive with limited nutrients, moisture, and oxygen, and in adverse pH conditions. The biofilm enables the microbial community to survive, colonise, and spread to contaminate other surfaces and food products via air, moisture, human contact, and other vectors.

Research on biofilms is still ongoing, and it has been found that microorganisms are able to communicate with each other to group themselves, share resources, and offer cross-protection through a molecular signaling technique called *"quorum-sensing."*

These are the typical steps of biofilm formation:



Note:

The best time to control biofilms is prior to step 3.
After this, the mature biofilms are much more difficult to remove because of their protective exopolymer matrix.

Biofilm Prevention Strategies
An Integrated Sanitation Approach

Optimal biofilm control starts with prevention. A proactive biofilm control strategy is necessary to consistently maintain the sanitary state of a food facility and ensure the production of safe and wholesome food. The following strategies can be implemented to mitigate risk in production facilities.

Risk-Based Environmental Monitoring of Facility Locations–

Facilities need to be on the lookout for hard-to-reach surfaces (food-contact or otherwise) that are generally difficult to clean, inspect, and maintain, along with the typical surfaces that also need to be cleaned regularly. For example,

- Ready-to-eat food contact surfaces:
  - ✓ Fibrous and porous-type conveyor belts
  - ✓ Filling and packaging equipment
  - ✓ Belts, peelers, and collators
  - ✓ Containers, bins, tubs, and baskets
  - ✓ Slicers, dicers, shredders, and blenders
  - ✓ Utensils
  - ✓ Re-useable gloves

- Surfaces that generally do not contact RTE Foods:
  - ✓ In-floor weighing equipment
  - ✓ Cracked hoses
  - ✓ Hollow rollers for conveyances
  - ✓ Equipment framework
  - ✓ Wet, rusting, or hollow framework
  - ✓ Open bearings within equipment
  - ✓ Poorly maintained compressed air filters
  - ✓ Condensate drip pans
  - ✓ Motor housings
  - ✓ Maintenance tools like wrenches and screwdrivers
  - ✓ Forklifts, hand truck, trolleys, and racks
  - ✓ On/off switches
  - ✓ Vacuum cleaners and floor scrubbers
  - ✓ Trash cans and other such ancillary items
  - ✓ Tools for cleaning equipment
  - ✓ Spiral/blast freezers
  - ✓ Ice makers
  - ✓ Aprons

- Plant environment:
  - ✓ Floors, especially cracks and crevices
  - ✓ Walls
  - ✓ Drains
  - ✓ Ceiling, overhead structures, and catwalks
  - ✓ Wet insulation in walls or around pipes and cooling units
  - ✓ Rubber seals around doors, especially in coolers
  - ✓ Metal joints, especially welds and bolts
  - ✓ Contents of vacuum cleaners

Hygienic Zoning and the Use of Colour-Coded Tools –

The GFSI (Global Food Safety Initiative) benchmarked food safety standards BRCGS, FSSC22000, IFS and SQF all require special measures to prevent cross-contact and cross-contamination. Colour coding is ideally suited to this. In the BRCGS standard it is mandatory that your cleaning equipment is suitably identified for intended use e.g. colour coded.

BRCGS Global Standard for Food Safety

requires colour coding or labeling for the identification of cleaning equipment.

FSSC 22000

is comprised of ISO standards that specify the need for cross-contact and cross-contamination

IFS Food Standard

mentions that the intended use of cleaning equipment shall be clearly identified. Cleaning equipment shall be used in a way that avoids cross-contamination.

SQF Code on Food Manufacturing

requires the separation of functions, products and zones based on risk.

LEAN

The use of colour coding of tools and equipment is also in line with the 5S LEAN system, which uses five steps – Sort, Set in order, Shine, Standardise and Sustain – to ensure the correct order, systematisation and ownership in a production process or facility.

Vikan Hygienic Zoning Planner

Food-Contact Tools

Non-Food Contact Tools

Effective hygienic zoning, as a risk-based means of separating facility areas and processes, can prevent or greatly minimise the spread of biofilms and, consequently, reduce the risk of product contamination. For example, an effective zoning strategy would segregate the people and equipment used for raw meat handling (low risk, high microbial contamination), from those used for ready-to-eat cooked meat handling (high risk, low microbial contamination). This type of zoning is most commonly achieved through use of separate areas or rooms, and the segregation message is often reinforced by the use of colour-coding.

Colour-coding can act as a visual cue that helps in maintaining the segregation of risk zones, processing equipment, and cleaning and food handling tools used for different purposes.

For example, a blue brush may be used to clean the surface of a food contact conveyor belt, while a red brush may be used to clean the floor. Or, only orange tools are used in the orange raw meat area

Strategies like zoning and use of colour-coding can help prevent the formation and spread of biofilms, and reduce the risk of product contamination.

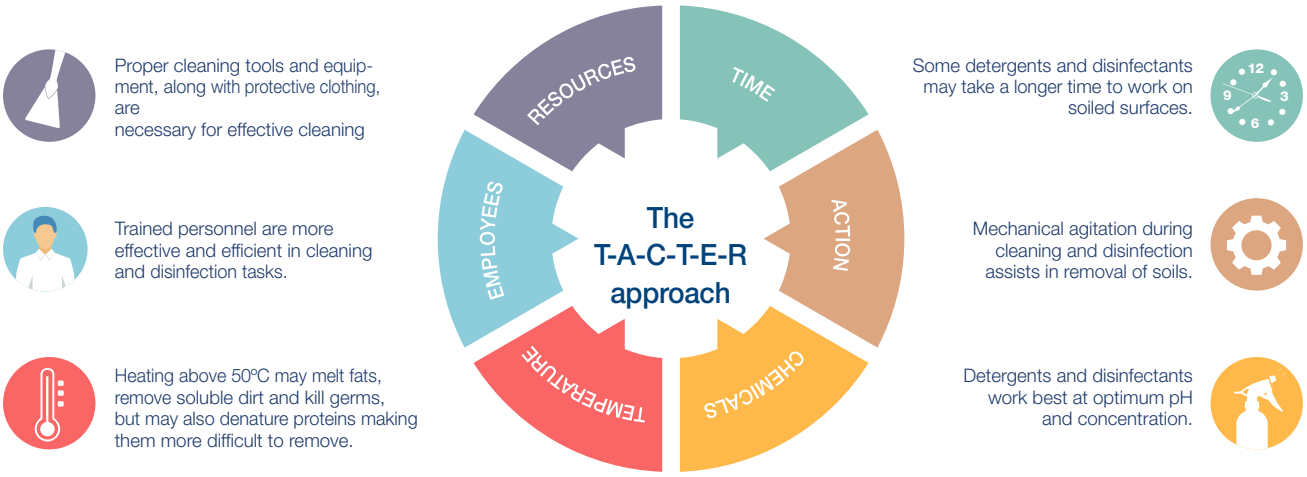
Biofilm Removal Strategies – A Six-Stage Approach with Emphasis on Manual Cleaning

According to Moorman and Jaykus (2019)[2], manual cleaning is important because, "one just can't sanitize one's way out of a persistent biofilm problem within a facility. Biofilm eradication, therefore, generally requires equipment tear-down, deep-cleaning and sanitation, and a follow-up verification."

The following six stage approach to cleaning and sanitation, with an emphasis on manual cleaning, is highly recommended:

(A) ASSESS YOUR TACTER PARAMETERS:

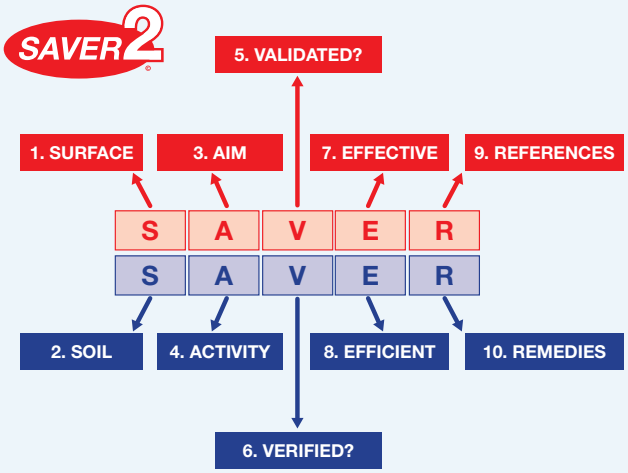
The TACT circle was originally developed by Dr. Herbert Sinner in 1960[3]. The model lists the parameters needed to remove soil from a surface. Vikan has added two parameters, "Employees" and "Resources," to make it a holistic model for effective cleaning:



When biofilms build up, generally, the TACTER requirements are intensified, meaning that the hygiene team will need to worker harder to remove thick biofilms

(B) DEVELOP A ROBUST SANITATION PROGRAM

When considering a biofilm removal strategy, at least the soil, surface, and the conditions need to be evaluated. The Double SAVER model was developed by Vikan to assist with understanding the considerations for a comprehensive sanitation program:



1. What type of **Surface** is being decontaminated?
2. What is the nature of the **Soil** being removed or reduced to an acceptable level?
3. What is the **Aim** of the decontamination action?
4. What level of procedural decontamination **Activity** is being implemented?
5. Is the decontamination process well **Validated**?
6. Is the decontamination process adequately **Verified**?
7. How **Effective** is the decontamination process?
8. How **Efficient** is the decontamination activity?
9. Are the processes supported by valid scientific, technical, or credible **References**?
10. Are **Remedies** in place to correct or prevent anything significant that could go wrong?

(C) HAVE A RISK-BASED CLEANING SCHEDULE IN PLACE

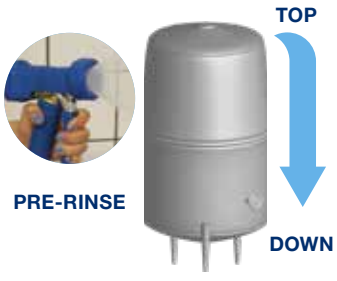
A cleaning schedule for effective sanitation of facility areas, fixtures, equipment, utensils, and tools must be adopted. This schedule will assist in preventing biofilm formation.

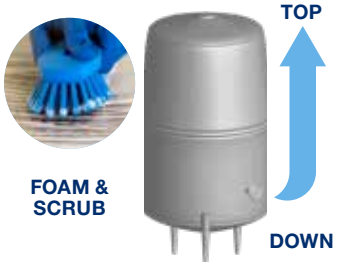
WHAT TO CLEAN?	HOW TO CLEAN?	WHEN TO CLEAN?	WHO DOES THE ACTIVITY?	HOW ARE PARAMETERS CONFIRMED?	HOW TO VERIFY EFFECTIVENESS OF CLEANING
ITEN / AREA	PROCEDURE	FREQUENCY	FREQUENCY	FREQUENCY	FREQUENCY
Food Preparation Tables	 Clear debris, wash and scrub with brush, rinse, and disinfect	- After production is completed - Before start of operations (disinfect only if clean)	Production Employee	- Confirm correct concentrations of detergents and disinfectants - Other resources provided	- Visual Check - ATP Test - Micro-swab
Floors at Production Zone	 Sweep debris with broom and dustpan, and throw in bin	- After production is completed - Once every 2 hours on accumulation of wastes	Production Employee	- Supervisor checks floor cleanliness - Resources e.g. broom, dustpan and broom provided	Visual Check

Note: This is a test example. Program may be more detailed and ranges from site to site

(D) ENSURE THE CLEANING STEPS ARE WELL DEFINED AND UNDERSTOOD BY EMPLOYEES

- 1. Secure equipment, disassemble, and dry-clean to remove debris
- 2. Pre-rinse equipment surfaces with potable water, from top to bottom
- 3. Apply detergent and foam, and scrub from bottom to top
- 4. Post-rinse with potable water and conduct self-inspection (by operator)
- 5. Conduct a formal post-cleaning inspection (usually done by QC)
- 6. Disinfect (with appropriate disinfectant) and assemble the equipment
- 7. Dry equipment and let supervisor verify as part of pre-op inspection





DIFFERENT TYPES OF CLEANING

HIGH-LEVEL CLEANING:

Tools with telescopic handles, such as condensation squeegees and hook brushes, help prevent biofilms on ceilings and overheads.

LOW-LEVEL CLEANING:

Angled brooms with long extension handles can reach relatively inaccessible surfaces like narrow junctions and corners.

DETAILED CLEANING:

Narrow bristle blocks with ergonomic handles are used on hard-to-reach nooks and crannies of equipment surfaces.

DEEP CLEANING:

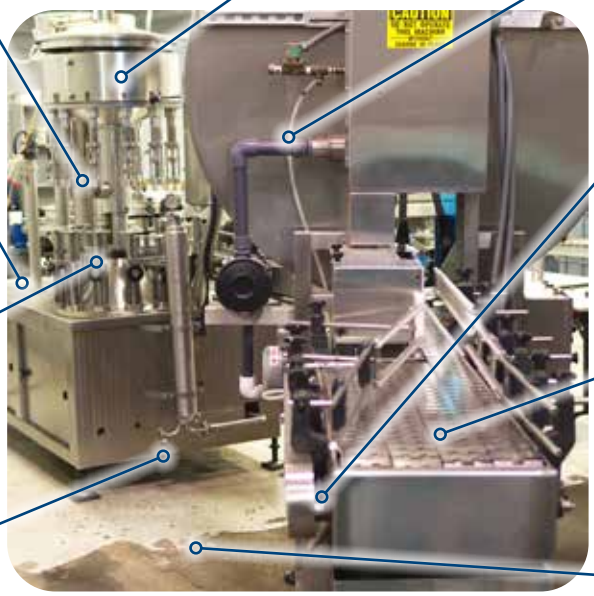
Scrubbing tools, chemicals, and water can be used to remove mature biofilms.

(E) CREATE A MANUAL CLEANING PLAN AND SELECT THE RIGHT TOOLS FOR THE JOB

Sanitation of a facility is not a “one-size-fits-all” approach. For instance, there will be different tool requirements for different locations as illustrated:

Below is an example of a piece of equipment within a processing environment, and the tools used for cleaning the surfaces:

Filling Machine



Item number:
53763
Tube Brush

Item number:
55003/5525
Pad Holder
Blue Holder/White Pad

Item number:
53743/29753
Overhead Brush

Item number:
35873
Hand Brush
Medium, Blue

Item number:
44013
Detail Brush
Stiff, Blue

Item number:
42873
Dish Brush
Medium, Blue

Item number:
41903
Washing Brush
Medium, Blue

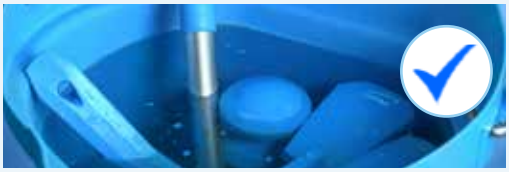
Item number:
70473
High-Low Brush
Medium, Blue

Item number:
77133/29623
Floor Squeegee
20", Double Blade, Blue

When cleaning a piece of equipment using a set of tools, be on the lookout for nooks and crannies that might also be harder to reach, inspect, or clean, and where biofilms may develop. It definitely pays to invest in hygienically designed equipment. Equally important is the selection and use of cleaning tools such as Vikan's Ultra-Safe Technology range of brushes, Ultra-Hygiene Handles and Squeegees, hygienically designed buckets and scrapers, that are easy to decontaminate before and after use.

Ultra-Safe Technology (UST) Brush Technology

(F) FOLLOW TOOL CLEANING AND MAINTENANCE PROTOCOLS



It is important to clean and disinfect tools before and after use as appropriate, as these can be potential biofilm habitats and vectors of bacterial cross-contamination. For instance, according to a UK government-funded study (Campden BRI)[4], 47% of the cleaning equipment sampled in food production facilities tested positive for *L. monocytogenes*. Therefore, tools that are easy to clean and maintain are preferred.

It is also necessary to regularly inspect and replace damaged and worn-out tools.

Key Points:

- Prevention is the best control strategy because once biofilms mature, they can become more difficult to remove using conventional cleaning and disinfection methods.
- Mature biofilms are likely to form on surfaces that are difficult to clean, reach, inspect, or maintain. Common trouble spots are drains, the undersides of equipment, high-level pipework and ceilings, crevices, nooks, and rough welds.
- The best time to remove biofilms is before they mature and produce a thick extracellular protective layer (prior to stage 3). After this point more aggressive chemicals and mechanical action may be required for their removal, which will result in damage to the surface being cleaned and make it more vulnerable to biofilm formation in the future.
- Clean before you disinfect: Clear the surface of debris, and clean with detergent using mechanical action. Then, rinse with water before applying disinfectant. Select the appropriate chemicals and follow the supplier's instructions on concentration, application, temperature, contact time, and health and safety information. If equipment teardown is required for manual cleaning, fully submerge individual parts in water while scrubbing or scraping. This helps prevent droplets from contaminating other locations.
- During manual cleaning, select the right tools to ensure effective biofilm removal. Bristle quality and type matters: Don't use very stiff bristles as they may scratch delicate equipment surfaces and spread droplets of the biofilm and contaminate other locations. Very soft bristles may not be effective at removing biofilms. Also, use a pipe brush of the right diameter to clean hollow pipes or you risk damaging the surface or not effectively cleaning them.
- Routine cleaning and disinfection may not be sufficient to remove all biofilms. Periodic deep cleaning, where equipment is stripped down before cleaning and disinfection, is recommended to minimise the risk of biofilm formation.
- In line with food safety regulations and standards, selection, care, and maintenance of cleaning equipment and tools are necessary to maintain sanitary conditions in food facilities.

How can Vikan help you?

Vikan provides specialised solutions and products, including colour-coded tools for cleaning and food handling where hygiene and food safety are critical. Our experience and focus on hygienic design strengthens our ability to provide comprehensive solutions to food processors.

We can help you with the proper selection, use, maintenance, and storage of tools and equipment that are required to clean or effectively remove biofilms from contact surfaces and handle food safely by minimising cross-contamination incidences, and thus preventing chances of biofilm formation within food facilities.

Our library of white papers and articles are designed to help you find the right solutions to your food safety challenges. Download our white papers and read our articles at the Vikan Download Center; https://www.vikan.com/int/services/download-centre.

To learn more about developing a robust biofilm control and proactive contamination prevention strategies, please read the following:

- *Biofilms:* https://www.vikan.com/int/services/biofilms
- *Colour Coded Segregation:* https://www.vikan.com/int/services/colour-coded-segregation
- *Webinar Archive:* https://www.vikan.com/int/services/webinar-archive
- *Ultra Safe Technology:* https://www.vikan.com/int/services/ultra-safe-technology
- *Cleaning Tool Maintenance:* https://www.vikan.com/int/services/cleaning-tool-maintenance

By making information on the latest safety news, regulations, and best practices accessible via our social media and our website, we hope to provide the industry with the support it needs. If you require any technical assistance and additional information about our products and services, kindly contact us at export@vikan.com.

Selected References

1. M W LeChevallier, C D Cawthon, and R G Lee (1988). Inactivation of biofilm bacteria. Appl Environ Microbiol. 1988 Oct; 54(10): 2492–2499.
2. Moorman, E., & Jaykus, L. A. (2019). Impact of Co-Culturing with Pseudomonas aeruginosa on Listeria monocytogenes Biofilm Physiochemical Properties and Sanitizer Tolerance. In IAFP 2019 Annual Meeting. IAFP.
3. Sinner, H. (1960) Über das Waschen mit Haushaltwaschmachinen: in welchem Umfang erleichtern Haushaltwaschmaschinen und -geräte das Wäschehaben im Haushalt? Haus & Heim Verlag, (8).
4. Holah, J.T. (1989). Effective microbiological sampling of food processing areas. Guideline No. 20, Campden & Chorleywood Food Research Association.

Vikan International

Islands Brygge 39, 2. sal
2300 Copenhagen

Phone: +45 96 14 26 10
Email: export@vikan.com

www.vikan.com