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project

Study of the CLEANING IN PLACE  
techniques

Public report

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# Introduction

The **Ozonecip Project** is a demonstration project that aims to contribute to the achievement of a reduction in the environmental impact of the sanitation operations carried out in the food industry through an innovative sanitation technique based on the use of ozone as an alternative sanitizing agent to other sanitation products commonly used. The demonstration activities will focus on clean in place (CIP) protocols. The potential environmental benefits will be tested in three sectors: brewery, winery and dairy. Three European centres will implement the project: Ainia (Spain) as coordinator, Bionord (Germany) and Gdansk University of Technology (Poland). Three companies will provide their industrial point of view: Allied domecq bodegas (winery), Becks (brewery) and Meiere-Genossenschaft e.G. Langernhorn (dairy).

This document is an output of the Task A Action A.2 "Study of the CIP". This document is a Public Report that shows some of the main information extracted from the corresponding full report submitted to the European Commission (Deliverables of the Project).

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## COVERED ISSUES

The different issues covered in the full reports are the following:

- ✓ Principles and practice of cleaning and disinfection operations
- ✓ Principles and practice of CIP systems within the subsector
- ✓ Automation, control and monitoring
- ✓ Equipment
- ✓ Chemicals employed
- ✓ Efficiency

In the following pages some of the most interesting information is summarised.  
Extended Reports delivered to the Commission

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# Cleaning and disinfection in FDM industries

## Concept of cleaning

The objective of cleaning and sanitizing food contact surfaces is to remove food soils and films which bacteria need to grow, and to kill those bacteria which are present. Cleaning is the complete removal of food soil using appropriate detergent chemicals under recommended conditions. It is important that personnel involved have a working understanding of the nature of the different types of food soil and the chemistry of its removal.

## Operational parameters

There are four interrelated operational factors which affect the overall cleaning process. When designing cleaning procedures these factors need to be carefully considered.

- **Time:** The longer a cleaning solution remains in contact with the equipment surface, the greater the amount of food soil that is removed. An increase in time leads to a reduction in the chemical concentration requirements.
- **Temperature:** Soils are affected to varying degrees by temperature. In the presence of a cleaning solution most soils become more readily soluble as the temperature is increased.
- **Chemical Concentrations:** Chemical concentrations vary depending upon the chemical itself, type of food soil, and the equipment to be cleaned. Concentration will normally be reduced as time and temperature are increased.
- **Mechanical Force:** Mechanical force can be simple hand scrubbing with a brush or as complex as turbulent flow and pressure inside a pipeline. Mechanical force aids in soil removal and typically reduces time, temperature, and concentration requirements.

# Cleaning and disinfection in FDM industries

## Methods of cleaning

**Foam:** Foam is produced through the introduction of air into a detergent solution as it is sprayed onto the surface to be cleaned. Foam cleaning will increase the contact time of the chemical solutions, allowing for improved cleaning with less mechanical force and temperature.

**High Pressure:** High pressure cleaning is used to increase the mechanical force, aiding in soil removal. In high pressure cleaning chemical detergents are often used along with increased temperature to make soil removal more effective.

**Clean in Place (CIP):** CIP cleaning is utilized to clean interior surfaces of tanks and pipelines of liquid process equipment. A chemical solution is circulated through a circuit of tanks and or lines then returned to a central reservoir allowing for reuse of the chemical solution. Time, temperature, and mechanical force are manipulated to achieve maximum cleaning.

**Clean Out Of Place (COP):** COP cleaning is utilized to clean tear down parts of fillers and parts of other equipment which require disassembly for proper cleaning. Parts removed for cleaning are placed in a circulation tank and cleaned using a heated chemical solution and agitation.

**Mechanical:** Mechanical cleaning normally involves the use of a brush either by hand or a machine such as a floor scrubber. Mechanical cleaning uses friction for food soil removal.

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# Cleaning and disinfection in FDM industries

## Methods of cleaning

The following is the typical procedure used when cleaning food processing equipment. The factors that influence cleaning (time, temperature, chemical concentration, and mechanical force), the method of cleaning, and the food soils to be removed will ultimately determine the cleaning procedures selected for use:

**Pre-Rinse:** Soiled equipment surfaces are rinsed with (maybe warm) water to remove the gross amounts of loose food soils.

**Cleaning Cycle:** Removal of residual food soils from equipment surfaces through manipulation of the four basic cleaning factors and the method of cleaning. Typically alkaline chemical solutions are used for the cleaning cycle.

**Rinse:** Rinsing of all surfaces with cold to hot water, depending upon the temperature of the cleaning cycle, to thoroughly remove all remaining chemical solution and food soil residues.

**Acid Rinse:** A mild acid rinse of the equipment neutralizes any alkaline residues left and removes any mineral soil present.

**Sanitize:** All equipment surfaces are rinsed or flooded with a sanitizing agent. Time and concentration are critical for optimum results

# Cleaning and disinfection in FDM industries

## Factors

**Water chemistry:** Water comprises approximately 95-99% of cleaning and sanitizing solutions. Water functions to:

- carry the detergent or the sanitizer *to* the surface
- carry soils or contamination *from* the surface.

The impurities in water can drastically alter the effectiveness of a detergent or a sanitizer. Water hardness is the most important chemical property with a direct effect on cleaning and sanitizing efficiency. (Other impurities can affect the food contact surface or may affect the soil deposit properties or film formation.) Knowing the water source available to a food processing plant is a must when designing a sanitation program.

**Properties of food soils:** Food soil is generally defined as unwanted matter on food-contact surfaces. Soil is visible or invisible. The primary source of soil is from the food product being handled. However, minerals from water residue and residues from cleaning compounds contribute to films left on surfaces. Microbiological biofilms also contribute to the soil buildup on surfaces. Since soils vary widely in composition, no detergent is capable of removing all types. Many complex films contain combinations of food components, surface oil or dust, insoluble cleaner components, and insoluble hard-water salts. These films vary in their solubility properties depending upon such factors as heat effect, age, dryness, time, etc. It is essential that personnel involved have an understanding of the nature of the soil to be removed before selecting a detergent or cleaning regime. The rule of thumb is that acid cleaners dissolve alkaline soils (minerals) and alkaline cleaners dissolve acid soils and food wastes. Improper use of detergents can actually "set" soils, making them more difficult to remove (e.g., acid cleaners can precipitate protein). Many films and biofilms require more sophisticated cleaners which are amended with oxidizing agents (such as chlorinated detergents) for removal. Soils may be classified as:

- soluble in water (sugars, some starches, most salts);
- soluble in acid (limestone and most mineral deposits);
- soluble in alkali (protein, fat emulsions);
- soluble in water, alkali, or acid.

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# Cleaning and disinfection in FDM industries

## Factors

**Quantity of soil:** It is important to rinse food-contact surfaces prior to cleaning to remove most of the soluble soil. Heavy deposits require more detergent to remove. Improper cleaning can actually contribute to build-up of soil.

**Surface characteristics:** The cleanability of the surface is a primary consideration in evaluating cleaning effectiveness. Included in surface characteristics are:

- **Surface composition:** Surfaces of soft metals and nonmetallic materials are generally less corrosion-resistant and care should be exercised in their cleaning. Aluminum is readily attacked by acids as well as highly alkaline cleaners which can render the surface non-cleanable. Plastics are subject to stress cracking and clouding from prolonged exposure to corrosive food materials or cleaning agents. Hard wood (maple or equivalent) or sealed wood surfaces should only be used in limited applications such as cutting boards or cutting tables provided the surface is maintained in good repair. Avoid using porous wood surfaces.
- **Surface finish:** Equipment design and construction standards also specify finish and smoothness requirements. 3-A standards specify a finish at least as smooth as a No. 4 ground finish for most application. With high-fat products, a less smooth surface is used to allow product release from the surface
- **Surface condition:** Misuse or mishandling can result in pitted, cracked, corroded, or roughened surfaces. Such surfaces are more difficult to clean or sanitize, and may no longer be cleanable. Thus, care should be exercised in using corrosive chemicals or corrosive food products



# Cleaning and disinfection in FDM industries

## Chemistry of detergents

Detergents and cleaning compounds are usually composed of mixtures of ingredients that interact with soils in several ways:

**Physically active ingredients:** alter physical characteristics such as solubility or colloidal stability (ionic and non ionic surfactants).

**Chemically active ingredients:** modify soil components to make them more soluble and, thus, easier to remove. (Alkaline builders, acid builders, water conditioners, oxidizing agents, enzyme ingredients, fillers, and other).

In some detergents, specific enzymes are added to catalytically react with, and degrade, specific food soil components

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# Disinfection in FDM industries

## Concept of sanitation

It is important to differentiate and define first certain terminology:

**Sterilize** refers to the statistical destruction and removal of all living organisms.

**Disinfect** refers to inanimate objects and the destruction of all vegetative cells (not spores).

**Sanitize** refers to the reduction of microorganisms to levels considered safe from a public health viewpoint.

## Types of sanitation

**Thermal Sanitization** involves the use of hot water or steam for a specified temperature and contact time.

**Chemical Sanitization** involves the use of an approved chemical sanitizer at a specified concentration and contact time

## Factors Affecting Sanitizer Effectiveness

### Physical Factors

*Surface Characteristics.* Prior to the sanitization process, all surfaces must be clean and thoroughly rinsed to remove any detergent residue. An unclean surface cannot be sanitized. Since the effectiveness of sanitization requires direct contact with the microorganisms, the surface should be free of cracks, pits, or crevices which can harbor microorganisms. Surfaces which contain biofilms cannot be effectively sanitized.

*Exposure Time.* Generally, the longer time a sanitizer chemical is in contact with the equipment surface, the more effective the sanitization effect; intimate contact is as important as prolonged contact.

*Temperature.* Temperature is also positively related to microbial kill by a chemical sanitizer. Avoid high temperatures (above 55°C [131°F]) because of the corrosive nature of most chemical sanitizers.

*Concentration.* Generally, the activity of a sanitizer increases with increased concentration. However, a leveling off occurs at high concentrations. A common misconception regarding chemicals is that "if a little is good, more is better". Using sanitizer concentrations above recommendations does not sanitize better and, in fact, can be corrosive to equipment and in the long run lead to less cleanability.

*Soil.* The presence of organic matter dramatically reduces the activity of sanitizers and may, in fact, totally inactivate them. The adage is "you cannot sanitize an unclean surface".

## Factors Affecting Sanitizer Effectiveness

### Chemical Factors

- pH. Sanitizers are dramatically affected by the pH of the solution. Many chlorine sanitizers, for example, are almost ineffective at pH values above 7.5.
- Water properties. Certain sanitizers are markedly affected by impurities in the water.
- Inactivators. Organic and/or inorganic inactivators may react chemically with sanitizers giving rise to non-germicidal products. Some of these inactivators are present in detergent residue. Thus, it is important that surfaces be rinsed prior to sanitization.

### Biological Factors

The microbiological load can affect sanitizer activity. Also, the type of microorganism present is important. Spores are more resistant than vegetative cells. Certain sanitizers are more active against gram positive than gram negative microorganisms, and vice versa. Sanitizers also vary in their effectiveness against yeasts, molds, fungi, and viruses.

## Types of chemical sanitizers

The chemicals described here are those approved by FDA for use as no-rinse, food-contact surface sanitizers. In food-handling operations, these are used as rinses, sprayed onto surfaces, or circulated through equipment in CIP operations. In certain applications the chemicals are foamed on a surface or fogged into the air to reduce airborne contamination .

- Chlorine based Sanitizers:
- Iodine
- Quaternary Ammonium Compounds
- Acid-anionic sanitizers
- Fatty acid sanitizers
- Peroxide

# Cleaning and disinfection efficiency validation

The manufacture of food products requires a clean and sometimes even a sterile environment. Companies routinely implement contamination control programmes to prevent introduction of physical, chemical and biological contaminants into their processing environment. These programmes involve the cleaning of various types of surfaces in a systematic manner that is validated for effectiveness and monitored regularly. Not only must the cleaning be done, it must be seen to be done and documented

<p><b>Cleaning methods</b></p> <ul style="list-style-type: none"><li>•Cleaning in place (CIP)</li><li>•Cleaning out of place (COP)</li><li>•Manual methods</li></ul> <p><b>Sampling methods</b></p> <ul style="list-style-type: none"><li>•Swabbing surfaces (Direct sampling)</li><li>•Rinsing (Indirect sampling)</li><li>•Boil out (Indirect sampling)</li></ul> <p><b>Contaminants</b></p> <ul style="list-style-type: none"><li>•Drug residues</li><li>•Excipients</li><li>•Cleaning agent residues</li><li>•Microbiological contamination</li></ul>	<p><b>Methods for verifying cleanliness include</b></p> <ul style="list-style-type: none"><li>•Direct surface analysis (visual),</li><li>•pH</li><li>•Conductivity</li><li>•TOC</li><li>•ATP bioluminescence</li><li>•Light microscopy</li><li>•Gravimetric analysis</li><li>•Titration</li><li>•HPLC</li><li>•TLC</li><li>•Electrophoresis</li><li>•FTIR</li><li>•ELISA</li><li>•Atomic absorption</li><li>•Ion chromatography</li><li>•UV spectrophotometry.</li><li>•Contact plates</li></ul>
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# Cleaning in place systems

## CIP concept

**Cleaning in Place (CIP)** is a method of cleaning designed to clean interior surfaces of tanks and pipelines of liquid process equipment. **CIP** allows process plant and pipework to be cleaned between process runs without the requirement to dismantle or enter the equipment. It can be carried out with automated or manual systems and is a reliable and repeatable process that meets the stringent hygiene regulations especially prevalent in the food, drink and pharmaceutical industries. In essence consists on making a chemical solution to circulate through the circuit of tanks and lines and then return it to a central reservoir allowing for reuse of the chemical solution. Time, temperature, and mechanical force are manipulated to achieve maximum cleaning. **CIP** is widely used in all types of process industries. It has been developed from the requirement that process industry plant must be used efficiently to gain maximum cost benefits. **CIP** covers a variety of areas but its main purpose is to remove solids and bacteria from vessels and pipework in the **food and drinks processing industries**

## CIP procedure

A cleaning program can be composed of the following steps, The steps included in each particular case depend on the nature of the soils and films to be removed :

- *Pre-rinsing.*
- *Caustic treatment.*
- *Intermediate rinsing.*
- *Acid treatment.*
- *Intermediate rinsing.*
- *Disinfection.*
- *Final Rinsing.*

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## Advantages of CIP systems

A Cleaning in Place system has many benefits to the end user, some of the main reasons for implementing Cleaning In Place are:

- Safety operators are not required to enter plant to clean it
- Difficult to access areas can be cleaned
- Production down time between product runs is minimised
- Cleaning costs can be reduced substantially by recycling cleaning solutions
- Water consumption is reduced as cleaning cycles are designed to use the optimum quantity of water
- The cleaning system can be fully automated therefore reducing labour requirements
- Automated CIP systems can give guaranteed and repeatable quality assurance
- Automated CIP systems can provide full data logging for quality assurance requirements
- Hazardous cleaning materials do not need to be handled by operators
- Use of cleaning materials is more effectively controlled using a CIP system

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The control of **Cleaning In Place** systems can vary from simple manual operation to fully integrated PLC controls with touch screen operator interfaces. The design of the control system will vary according to the process being cleaned and the customers' requirements

### Controls and Functions:

- The flow in the return pipe is monitored for recognizing system errors.
- The temperature in the return pipe is monitored during the caustic and hot water phase.
- Flow control in the prerun for adapting the flow to the CIP object at an optimum.
- The times for the program steps are variably settable.
- On tank cleaning the prerun is controlled by pulses, if required.
- The dosing of the disinfectant is done proportionally to the water flow.
- The cleaning tanks are always automatically re-filled if the level has fallen below a certain limit value.
- The increase in concentration of the caustic solution and the heating of the cleaning agents is effected automatically.
- The cleaning cycles work independently of each other.

## Control of efficiency of CIP systems

The control of in-place cleaning is a two part operation. The first involves managing the process itself to ensure that every part of the cleaning cycle is performed optimally. This does not normally involve any microbiological procedures; it consists of monitoring such things as time, temperature, detergent concentration, flow rates etc. The second part involves assessing whether the procedures have been effective and this is where microbiological controls are often used. Traditionally microbiological methods have not had a role to play in ensuring CIP effectiveness but have been used solely for assessment. With the advent of new rapid systems this is beginning to change.

The main reason for the lack of application of microbiological methods for quality assurance is one of speed. In order to be able to control a process it is necessary to obtain information in real time. Traditional microbiological procedures, relying as they do on growth of spoilage organisms, are inevitably very slow and can only provide retrospective reassurance of adequate cleaning. In contrast, techniques which measure physical or chemical characteristics can provide a response rapid enough to enable operational decisions to be made. Nowadays, microbiological techniques are becoming available which can provide information quickly enough for process control. They can only do this by dispensing with the need for micro organisms to grow and by measuring physical or chemical changes associated with the presence of living organisms.

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### Methods for Ensuring Cleanliness of Plant: operational parameters

These methods are not microbiological in nature they are essential for effective control of CIP operations. If these checks are not in place the failure of the cleaning procedure is a certainty and any subsequent microbiological investigations will be a waste of time and effort. Many procedures are available for ensuring the effectiveness of in-place cleaning. Those depending on measurement of physical parameters include:

- cycle times
- solution temperatures
- flow rates
- Pressures

Additionally, a wide range of chemical analyses can be used including:

- detergent concentration (using conductivity)
- alkalinity (either in-line or off-line)
- specific chemical activities (e.g. sequestrant concentration)
- pH
- soil load of detergent solution (this can be determined by measuring colour, suspended solids, tendency to foam etc.)
- causticity

By using data obtained in this way it is possible to ensure that the procedures used will be effective for cleaning and sterilising the plant. For instance, measurements of time, temperature and causticity of a detergent can be used to ensure that the appropriate biocidal "dose" has been given to a piece of equipment by referring to appropriate data. A major advantage of this type of control is that it is immediate and the operator or the automatic control system can react to the results in time to correct any problems.

However, despite the sophisticated control and measurement systems now available for quality assurance of CIP procedures, there is still a need for ensuring that the process has actually worked. This is an area where microbiological methods can take their place alongside physical and chemical measurements.

**Visual Inspection** This is, of course, a very simple procedure involving merely looking at the equipment which has just been cleaned. Although apparently trivial, this is a very fast and valuable approach for assessing the efficiency of CIP systems. It is possible to assess cleanliness and to detect residual soil and adsorbed microbes. If, on inspection, plant appears dirty then, without doubt, the CIP system has failed. The response is instantaneous and there is no need for any further checks. Such visual inspections can be carried out when doing the assessments or collecting samples for laboratory analysis, emphasising the importance of brewery microbiologists keeping their eyes open when working on the plant. Although it is a valuable procedure, the main problem with visual inspections is that access to the plant is required which, with modern equipment, can be difficult

**Plant Swabbing** This technique, involving rubbing a swab over a surface in order to pick up any contaminants, can be used for both chemical and microbiological analyses. Once again, access to the plant is required. When performing a swab analysis it is extremely important that a defined area is monitored if results from different equipment and different samples are to be compared. Care must also be taken when deciding which parts of the plant to swab; monitoring only easily accessible areas can lead to optimistic results whereas the examination of poorly accessible areas alone can give pessimistic results. Again the person carrying out the collection of the swabs needs to use their eyes. If the swab becomes visibly dirty whilst the sample is being taken, inadequate cleaning is immediately indicated.

Depending upon the analysis system employed this technique can detect both residual soil and microorganisms. Two approaches can be used for taking the samples. One involves rubbing sausage-shaped agar medium over the surface being investigated and then incubating the agar to assess whether anything grows. This is not really appropriate for CIP monitoring because it leaves residues of growth medium on the freshly-cleaned surface. By far the best approach is to use conventional swabs (sticks with an area of cotton, alginate or synthetic material on one end) and then transfer any collected material into an appropriate solution which can be tested for the presence of dirt or microbes

**Final Rinse Sampling** This is in effect a special case of swabbing. Either a pressure spray is used to rinse a vessel and the liquid draining out collected and analysed or, more usually, a sample of the final rinse from the CIP sequence is collected. The major advantage of this type of sampling is that access is not required. However for the test to be of any value it is essential that the rinse fluid makes good contact with the surfaces being examined. Additionally the liquor used for the final rinse must itself be sterile or the test will be worthless. There are a number of ways of sterilising this liquor, both physical (ultraviolet light, heat, filtration) or chemical (silver, ozone, chlorine dioxide, peracetic acid). Where terminal sterilants are added it is vitally important that these are neutralised before any tests are carried out since the sterilant will continue acting in the test medium and give a false negative result. Final rinse samples can, of course, be assessed for the presence of product, chemical contamination or microbes but in all cases the contaminant materials must be either soluble or physically removed by the rinse if they are to be detected.

**Testing Next Batch** Once again access is not required to carry out this type of test, but as a method for detecting CIP failure, it leaves a lot to be desired since, by its very nature, a positive result is obtained by detecting contamination and potential spoilage of the final product. Hence this is not a method to be recommended unless it is impossible to use any of the other techniques described above. "Clear" results from forcing tests of packaged beer can give a certain degree of reassurance; failures however cause a large workload for brewing and laboratory personnel since the problem may lie almost anywhere within the brewery.

The choice of method largely depends upon whether it is possible to gain access to the plant. If access is possible then a combination of final rinse sampling, swabbing and visual inspection should be used. If access is not possible then there is no other choice but to use final rinse. In a modern plant designed for CIP operations, final rinse sampling alone will probably be adequate. In older plant not originally intended for in-place cleaning, final rinse sampling can be misleading since pockets of contamination may go unnoticed and the benefits of visual inspection will be lost.

## Cleaning and disinfection in wineries

The most important and frequent cleaning operation performed on closed equipment within the winery industry, is by far, the cleaning of holding tanks, although other closed equipment is also cleaned, as filters or centrifuges and heat exchangers in some companies. Nevertheless, these operations are less frequent and much less water consuming. The cleaning of tanks is the only waste water produced in some wineries at all, and is the only wastewater produced most of the time throughout the year in lots of wineries. Frequent cleaning of tanks because wine is clarified by gravity settling and moved from one vessel to another several times prior to filtering throughout the year. Fermentation of musts into wine is primarily done in big holding tanks. Cold stabilisation of fermented wines is performed in tanks and after that may be filtered and transferred to storage tanks prior to bottling. Fermented and already filtered wines may be mixed at the appropriate percentages to obtain the desired final product needing to use new tanks for the final product. Thus, the wine is moved from one tank to another very frequently and the need for cleaning of tanks is intensive in wineries



# Cleaning and disinfection in wineries

## General tank cleaning procedure in wineries

First rinse with a small quantity of pressure clean water in order to remove remnants on the bottom and fouled at the walls of the tank by mechanical force. Such waters are often pumped and collected in another holding tank and liquid is later sent to a distillery for alcohol recovery.

Wash with detergent and/or sanitizing agent in water solution in a closed loop for a certain time. Once the cleaning cycle is over the cleaning solution is discharged to the drains. Commercial products employed are, frequently, solutions with sodium hydroxide, sodium hypochlorite, sanitizers such as peroxy-acetic acid (PAA) that is an equilibrium mixture of acetic acid and hydrogen peroxide, hydrogen peroxide, etc. The Alkaline solution will remove protein soils and tartrate salts fouled at the walls of the tanks but will not act as a disinfectant. Depending on the process that has been carried out inside the tank (fermentation, cold stabilisation, storage of final product...) and thus the characteristics of the remnants that will be present in the waste wash water, such waters may be collected to be sent to tartrate extraction (e.g. after cold stabilization of wine) or for alcohol extraction. Some wineries use hot water at around 80 °C for sanitizing purposes.

Final rinse with clean water in open loop, such wash water is directly discharged to the drains.

Applying just steps 1 and 3 is common practice in most wineries. Step 2 is carried out from time to time for fermentation tanks and often in stabilisation tanks. Disinfection with e.g. peroxy-acetic acid hot water (80°C) is performed for the cleaning of tanks in the production of some particular wines such as "cava" where yeasts are added to the wine prior to the second fermentation of the wine. The second fermentation, in this type of product, is undertaken inside the bottles to get the characteristics of the final product. In such case the tanks where yeasts and sugar are added to the wine are often cleaned as usual plus a final disinfection step with peroxy-acetic acid and then a final rinse with sterilised water is applied. On the other hand, some bottlers perform a rinse with a disinfecting agent prior to the final rinse although its need is not fully justified. Although automated CIP techniques would fit very well the cleaning operations performed in the winery industry, manual CIP cleaning is still widely carried out. In such case a mobile pump and a mobile spray ball is moved from one tank to another tank and the selected cleaning solution is circulated through the tank being cleaned for a certain time after that, the wash water is discharged, most of the times, to the drains although, depending on the case in some wineries, it may be diverted at the end of the cleaning cycle to another tank for recovery of valuable products.

## Cleaning and disinfection in the dairy sector

The objective of cleaning dairy processing equipment is to achieve chemical and bacteriological cleanliness, which means that the equipment is first thoroughly cleaned with chemical detergents followed by disinfection with a disinfecting agent. The best known and almost commonly used in the dairy industry is the CIP system regarding to closed equipment such as pasteurizers, milk storage tanks, fermentation tanks for yogurt production, etc. Thus, rinsing water and cleaning solutions are pumped through all the components that are in contact with product and some equipment has built-in cleaning nozzles to improve the distribution of the cleaning solution. The cleaning solutions are generally distributed to the CIP circuits from a central CIP station consisting of several tanks for storing of the cleaning solutions. The solutions are heated by steam and their concentration is constantly monitored and adjusted.

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# Cleaning and disinfection in the dairy sector

## General tank cleaning procedure in dairies

The cleaning program differs according to the equipment to be cleaned, but the a complete program would include at least some of the following steps:

- pre-rinsing with water. The equipment is rinsed with warm or cold water to remove any product residues for 3 – 10 minutes, and the rinsing water is usually discharged to the drain system;
- secondly, the equipment is cleaned by circulation of an alkaline solution (usually sodium hydroxide of 0.5 – 1.5 %) at 75°C for about 10 minutes, but equipment like pasteurisers, with hot surfaces require longer circulation times and stronger solutions. Commonly, the returning cleaning solution is directed back to the detergent tank for reuse. For this purpose, the return pipes are usually equipped with conductivity transmitters, which detect the content of alkaline in the pipe.
- If required, alkaline cleaning is followed by cleaning with acid. In this case an **intermediate rinsing** with warm or cold water must be carried out between the cleaning steps in order to rinse out the alkaline solution. The acid solution (nitric acid of 0.3 – 0.7%) is circulated for about 5 minutes at 65°C. “Hot” equipment requires a circulation time of around 30 minutes. The acid solution is also recovered for reuse.
- Final rinsing, where any remaining cleaning solution is rinsed out with warm or cold water. Chemical-free water from the final rinsing is usually collected and reused for pre-rinsing.
- Disinfection step is normally carried out immediately before the production line is to be used again. This can be done either chemically by use of a disinfecting agent (e.g. hydrogen peroxide, peracetic acid, sodium hypochlorite), or by circulating hot water of 90-95°C for about 10 minutes.
- Rinse. If the equipment has to be cooled down or if the disinfecting agent must be flushed out, the equipment is rinsed with cold water again. This step of cleaning can be taken in different way for special equipment, like UF-plants or other membrane appliances, which has its own special detergents and internal cleaning circuits in order to prevent damage to the membranes. The chemicals used are mainly phosphoric, sulphuric and hydrochloric acid as well as potassium hydroxide.

## Cleaning and disinfection in breweries

cleaning and disinfection operations performed with CIP systems, have to be designed and used according to target equipment to be cleaned. The rinsing times, cleaning solutions and temperature have to be monitored and adapted to the target equipment's requirements in order to get satisfactory cleaning and disinfection results. This is shown in the above listed CIP programs tables, where the different target equipments are cleaned with different rinsing times, cleaning solution concentrations, temperature, rinsing time and cycles.

There are some critical zones in the brewery's facilities where the development of bacteria is most dangerous. These zones: wort cooling, yeast cellar and fermentation cellar. Thus, tables 4 and 6 show some of the cleaning programs used in these critical zones are performed, either with high concentration of cleaning solutions (e.g. 4,0 % of alkaline cleaning solution for the wort cooler and the yeast cellar) or with additional cleaning rinses like e.g. special alkaline cleaning or steam sterilisation. Moreover, the alkaline cleaning programs used in the yeast cellar are performed with hot cleaning solutions, with a temperature more than 85° C, that enhances even more the effectiveness of bacteria removal by the different rinses. In Some cleaning programs where rinsing is performed with less concentrated solutions, the contact time has to be longer, like e.g. the pipework in the fermentation cellar that is cleaned for 60 minutes, with an average alkaline and acidic cleaning solution concentration of 1,5%. The cleaning frequency is also one key point to keep in mind, as it is clearly defined, with 1-2 daily rinse cycles like in pipework and pump loops. The fermentation tanks and the yeast circuits in contrast, are to be cleaned every time they are used. Surfaces like walls, floors, CO2 conductions or water hoses are to be cleaned every week or when it is requested, so the cleaning cycle is much less frequent.

During the final steps of the brewing process, which involve the storage cellar and filtration step, cleaning and disinfection play also a main role. Although they are not critical zones regarding bacterial development due to low temperatures, their control is strictly necessary to ensure the final product's optimal quality.

In the storage cellar, special attention has to be paid to the storage tanks, the transfer tanks and transfer pipework As shown in table 10 these surfaces require more frequent cleaning activities with long contact times which range up to 60 minutes. The pipework in the filtration zone are cleaned using high temperature (above 85° C), and are the most frequent cleaned surfaces in this area. The concentration of the all cleaning agents used is around 2,5%.

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# Cleaning and disinfection in the brewery sector

## General cleaning procedure in breweries (closed equipment)

The following table shows typical CIP programmes used in breweries. The programmes are adapted to the part of the process to be cleaned, and some of the steps: alkaline, acidic, or disinfection, can be left out:

Action	Temperature	Duration
Prerinsing	Cold or hot	5-10 min
Alkaline cleaning (NaOH 1,5-4%)	Cold or hot	10-60 min
Intermediate rinsing	Cold or hot	10-30 min
Acidic cleaning (Phosphoric, nitric or sulphuric cleaning (1-2%))	Cold	10-30 min
Intermediate rinsing	Cold or hot	10-30 min
Disinfection by disinfectant solution by hot water	Cold 85-90° C	10-30 min 45-60 min
Final rinsing	Cold	5-10 min