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# UNIT 15 CLEANING-IN-PLACE (CIP)

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## Structure

- 15.0 Objectives
- 15.1 Introduction
- 15.2 Procedure of Cleaning-In-Place Process
- 15.3 Preparation and Supply of Cleaning Solution
- 15.4 Features of CIP System
- 15.5 Sanitization in CIP Process
- 15.6 Important Instructions and Precautions for CIP System
- 15.7 Let us sum up
- 15.8 Key Words
- 15.9 Some Useful Books
- 15.10 Answers to Check Your Progress

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## 15.0 OBJECTIVES

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After reading this unit, we should be able to :

- <sup>2/21</sup> give the basic principles of cleaning-in-place process
- <sup>2/21</sup> state the requirements and usefulness of CIP in dairy plants
- <sup>2/21</sup> specify various equipment and containers requiring CIP
- <sup>2/21</sup> outline special considerations that are required in designing CIP system/line
- <sup>2/21</sup> give procedure of CIP
- <sup>2/21</sup> indicate various accessories required for performing cleaning-in-place operation.

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## 15.1 INTRODUCTION

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Milk processing and handling equipment/containers are desired to be clean, dry and sanitized to prevent cross contamination of milk/milk product during handling & processing operations. Small and simple construction equipment could be manually cleaned with hand brushes and detergents. Some times these equipment/containers are dismantled and their parts are cleaned/sanitized individually. Some of this type of containers could also be cleaned through specially designed washing machines like can/crate washers. However there are number of other equipment, containers and processing circuits, which have very compact design and not possible to clean manually or they are so larger in size that unsuitable for cleaning in washing machines. This type of equipment and containers are preferably cleaned by special cleaning procedure termed as “Cleaning-In-Place or CIP”.

In the CIP process number of cleaning operations are performed on the equipment/ container/processing circuits one by one in certain sequence according to the plant hygiene programme. In this way instead of taking equipment/containers to the detergent solution or washing machine for cleaning/sanitizing, the flushing/cleaning/ sanitizing solutions are taken to them through specially designed cleaning system. The experiments and industry experiences have shown highly effective result from the CIP system along with several other benefits in terms of saving of manpower, time and chemicals. The effectiveness of CIP system is largely dependant on factors like time, temperature, detergency and physical action involved

The equipment susceptible to this technique of cleaning are said to be of CIP design. Most significant CIP design dairy process equipment include: milk chiller,

milk pasteurizer, milk tanks/silo, evaporator/dryer, milk process line, milk tankers, etc.

## 15.2 PROCEDURE OF CLEANING-IN-PLACE PROCESS

The CIP process may be applied to process circuit (piping systems) and associated process equipment by re-circulating rinse, detergent, and sanitizing solutions through circuits comprising of re-circulating unit consisting of pump(s), valve(s) and supply tanks to perform series of above operations. The cleaning-in-place operation is usually done in the following manner:

- <sup>2/21</sup> Take clean and soft water of required quantity in each CIP tank (cool /hot water, detergent, acid and sanitizer tanks). Maintain the concentration and temperature of each tank. For this the tank should be fitted with temperature and pH indicators.
- <sup>2/21</sup> As soon as processing is over, flush the equipment/container/process circuit with clean and soft cool water so that residual milk/milk product comes out.
- <sup>2/21</sup> After flushing is over pre-rinse with clean water at normal ambient temperature for 10 minutes to loosen the adhered milk/milk product comes out.
- <sup>2/21</sup> Now circulate detergent solution of 0.5 to 1.0% concentration and maintain recirculation at 70 to 75°C for 25 to 30 minutes or as desired in the CIP design.
- <sup>2/21</sup> Now circulate hot water maintained at 80°C for 10 minutes.
- <sup>2/21</sup> If required to remove water scale and milk stone by circulating acid solution of 0.5 to 1.0 or as decided in the CIP programme of dairy at 65-70°C for 25 to 30 minutes. Usually acid circulation is done at certain set intervals (say one week or fortnight period) and therefore skip this step in the daily/routine CIP.
- <sup>2/21</sup> If acid is circulated then rinse by circulating water at ambient temperature for 10 minutes and then again circulate the detergent solution for 25 to 30 minutes as described in the previous step.
- <sup>2/21</sup> Flush with water for 10 minutes.
- <sup>2/21</sup> Circulate hot water maintained at 80° to 85°C for 15 to 20 minutes to get sterilization of the surface.

### Check Your Progress 1

1. Describe the various steps of “Cleaning-in-Place” process?  
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2. Name the various equipments, vessels/containers/process lines requiring Cleaning-in-Place in a multi-product dairy plant?  
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3. Why does acid solution re-circulation required in a CIP ?  
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## 15.3 PREPARATION AND SUPPLY OF CLEANING SOLUTIONS

In a CIP system, there is a provision for supply and re-circulation of clean & soft water, hot water, detergent, acid and sanitizing solutions. There are following methods for preparation and supply of these items to the place of cleaning:

### i. Centralized CIP System

A well-equipped centralized CIP system has insulated tanks of suitable sizes for storing water, alkali, acid and sanitizing solution. These tanks contain arrangements for water feeding, chemicals dosing, heating along with provisions of level/volume, temperature, concentration and/or pH indicators. Generally tanks are made of stainless steel of SS-304 or SS-316 quality. Pumps, valve & piping is used to forward and return the solutions (Fig. 15.1).

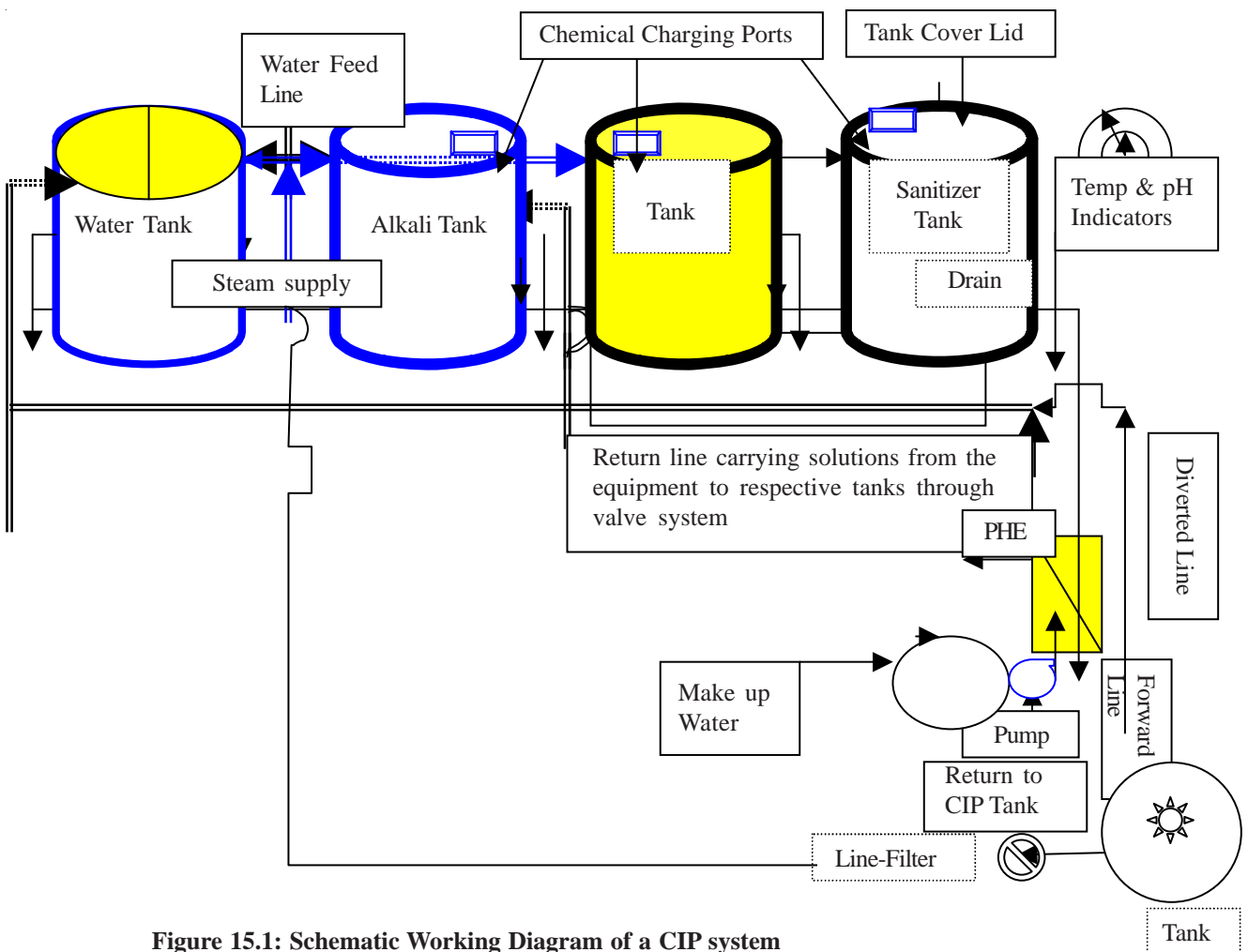


Figure 15.1: Schematic Working Diagram of a CIP system

### ii. Standalone type CIP System

The balance tank is used for taking water. The detergents, acid or sanitizers are dosed in the cold water. The heating system of the equipment is used for heating the solution, which is circulated through the feed pump or other pump specially provided for this purpose.

## 15.4 FEATURES OF CIP SYSTEM

Following features are noteworthy in CIP systems:

### i. The heating arrangements

Usually steam at 2 to 3 Kg/sq.cm. pressure is used for heating the CIP tanks. For

this steam is supplied in the coils in the tank or jacket of the tank. It has been observed that steam heating provision in tanks results in water evaporation and creates unhygienic conditions and as such results excessive loss of heat. At the same time due to loss of temperature during supply from tanks to place of cleaning, there are chances of non-achievement of desired temperature in for the CIP of equipment. This problem is corrected in the modified CIP system, in which various solutions are heated to the required temperature in a plate heat exchanger placed nearer to processing equipment/vessel. This type of arrangement is not only energy efficient but on the other hand results effective cleaning due to better control over the temperature of cleaning solutions.

## ii. The preparation of solutions

Following steps are taken for preparing various solutions in the tanks of CIP system:

- <sup>2/21</sup> Drain the dirty solution from the tanks and clean thoroughly.
- <sup>2/21</sup> Feed the tanks with required quantity of water by opening water line valves
- <sup>2/21</sup> Dose various detergent/acid/sanitizers in measured quantity in the respective tanks to get proper concentrations.
- <sup>2/21</sup> Open steam valve in the water tank, if hot water is required, otherwise not.
- <sup>2/21</sup> Heat the alkali and acid tank to achieve required temperatures.
- <sup>2/21</sup> Alternatively in the modified system where plate heat exchanger (PHE) is used for heating the solutions, pass the particular solution through the PHE and re-circulate till required temperature is achieved. Now forward the heated solution for the purpose of cleaning.

## iii. Operation techniques of CIP system

The CIP system is operated with following three techniques, in which the solutions are taken from tanks, heated to a particular temperature and circulated for cleaning for desired period.

**Manual System:** In this type of system all the valves, pumps are operated manually by a trained operator.

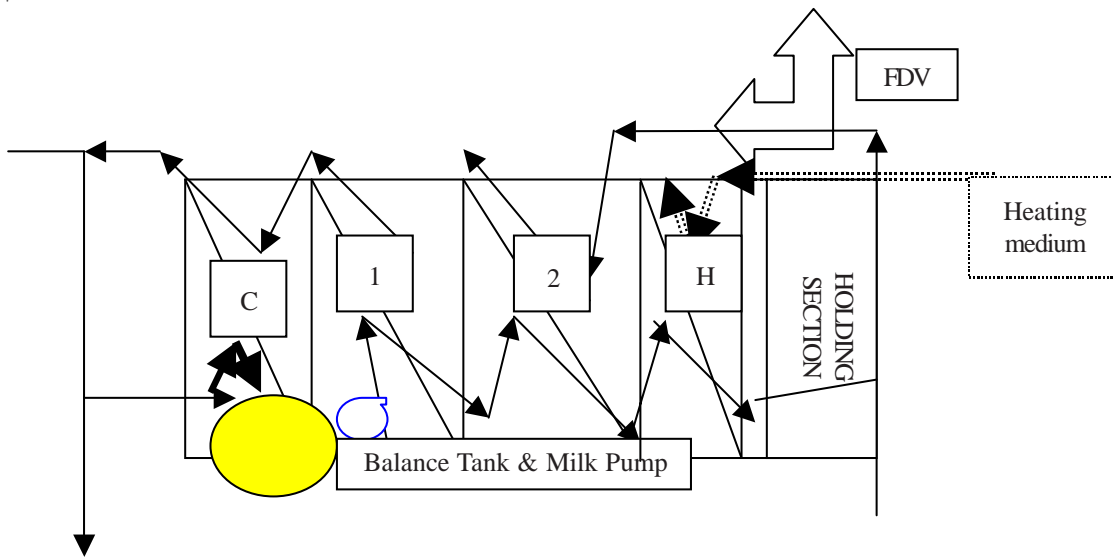
**Semi Automatic CIP System:** This type of system are provided with pneumatic valves and operated through skilled operator and/or time/temperature control relays known as timer.

**Automatic CIP System:** In this type of CIP system all operations including maintenance of concentration, selection of tanks, cleaning equipment, duration and temperature of solution is done automatically as per the set cleaning programme of the plant. Since cleaning of milk equipment, process circuit and vessels are the repetitive in nature; hence use of automatic system demands application of automation. This type of system makes mandatory the application of two principles; namely, 1) proper engineering of the product piping system and a CIP supply-return system, and 2) the installation of a permanently located recirculating unit. The automatic system consist of a) program sequence controller to time all portions of the cleaning cycle, b) adjustable set-point temperature controls to provide variable supply-line solution temperature, c) air-operated solution flow-control valves, and d) detergent feed equipment to transfer chemicals automatically into the system as required for the cleaning processes.

## iv. Standalone type cleaning-in-Place system

There are number of dairy equipment in which centralized CIP system is not used and other special type of CIP arrangements are inbuilt or provided during installation. Milk/cream pasteurizer, milk evaporator/condensing plant are some such most

prominent examples. In this type of process equipment similar process as discussed above is carried out. However, these equipment are cleaned by their own flow circuit. The balance tank is used for taking water, dosing chemicals and feed pump to circulated the desired solutions of required concentration for certain period. The heating system of the equipment is used for heating the solution. One of the CIP circuit of milk pasteurizer (PHE) is depicted in the Figure 15.2.



**Figure 15.2: CIP Circuit of Milk Pasteurizer**

LEGENDS: C stands for chilling section, 1 stands for Regeneration-I, 2 stands for regeneration-II, H stands for Heating section,

- Represents Cooling medium line, which is shut off during CIP, &
- Represents heating medium line (steam or hot water heating).

The solution after heating to required temperature in heating section goes to holding and then passes through FDV.

The CIP of milk pasteurizer is done mainly in three flow patterns; viz: a) by using regular product supply and discharge line, b) simple method of using split flow with few changes, and c) providing highest holding tube velocity.

In the split flow technique, various section of PHE have circulation of solution without production of excessive pressures and prevent excessive leakage through gaskets. In this about three times solution is forced through the plates as compared to the regular flow path, causing better filling of plate and air purging. However this requires high capacity of pump to force larger volume and need special size of inlet and outlets.

**Check Your Progress 2**

1. Discuss about the basic CIP system facilities?

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2. What are the various types of heating arrangement employed for CIP process?

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3. Discuss about the automatic CIP?

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### 15.5 SANITIZATION IN CIP PROCESS

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Sanitization process of equipment and containers is done after cleaning operation. The detail process and requirements is discussed in the unit-13: “Methods of cleaning and sanitization”. After cleaning is over, surfaces are properly rinsed and then according to the requirement sanitization is done. Where hot water sterilization is required, the heated water at about 80 to 85°C is passed through and circulated for 15 to 20 minutes. In other type of system, sanitizer solution of required concentration (depending upon the chemical used and level of sanitary condition is desired) is passed through and drained.

#### Check Your Progress 3

1. Describe sanitization processes for milk pasteurizer and milk silos?

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### 15.6 IMPORTANT INSTRUCTIONS AND PRECAUTIONS FOR CIP SYSTEM

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- 1) Use of “Material Safety Data Sheet (MSDS)” provided by the manufacturers is very important as every detergent and sanitizers has its specific handling requirement depending upon their reactive nature with handling personnel, equipment and surrounding atmosphere. In order to prevent unwanted harm one should read carefully the safety instructions given about the chemical and necessary application techniques. Most preferably these MSDS should be displayed near the place of use.
- 2) The washing machines are designed by keeping certain types of detergent/sanitizer characteristics in mind and hence manufacture’s recommendations must be looked into while selecting the detergent and sanitizers.
- 3) The milk lines should be isolated from the CIP circuit to prevent danger of contamination of milk with the detergent/acid solutions. Special care is required during circulating acid in the CIP system. Leakage of acid solution through defective, open valves may curdle the milk. The CIP line of the vessels/equipment containing milk should be preferably completely plugged off with the help of proper size blanks.
- 4) Interlocking arrangement is also done for protection against intermixing of products and intermixing of products with cleaning solutions during CIP operations. Interlock circuits may have any desired condition mandatory prior to establishment of product transfer or CIP cleaning operation.
- 5) Other controls like level (high and low) control, temperature control are to be calibrated to ensure protection against unsafe operations.
- 6) Specially designed balls used for spray of detergent solutions in CIP process should be fitted properly and inspected for clogging of holes. Periodical cleaning ensures effective spray and cleaning.

1. What precautions are required while doing acid cleaning?

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2. Write about the preventive maintenance of CIP system?

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**15.7 LET US SUM UP**

Dairy processing requires number of specially designed equipment like milk pasteurizer and vessels like milk Tanks and Silos of large volume and dimensions. It is practically difficult to clean them manually. The filling and emptying operations are frequently carried out to match the production objectives. Under these conditions, it requires for easily manageable cleaning and sanitization system for maintaining the cleanliness of such milk handling items.

Cleaning-in-process is such a technique that fulfills the above requirement of dairy plants. This system employs series of tanks for preparing and supplying the various cleaning solution as per the requirements. Suitable heating arrangements are helpful in maintaining the solution temperature during cleaning operation. Requirement of human skill is substituted by employing fully automatic CIP system, which once programmed takes care of required cleaning very effectively, if all precautionary actions like up-keep of tanks, filters, spray ball, pumos, heating medium and accessories etc. are undertaken timely. In these system hot water or sanitizer solution disinfects the surface at the end of the CIP process.

**15.8 GLOSSARY**

<b>Acid</b>	:	Chemical used for cleaning, pH less than 7.00
<b>Alkali</b>	:	Chemicals used for cleaning, pH more than 7.00
<b>CIP</b>	:	Cleaning in place; supply solution & cleaning at the place of cleaning.
<b>Cleaning</b>	:	The removal of soil, food residues, dirt, grease or other objectionable Materials
<b>Clean water</b>	:	Water without containing microorganisms contamination
<b>Clear water</b>	:	Water which is free from foreign dirt/dust particles.
<b>Contamination</b>	:	The occurrence of any objectionable matter in the product
<b>Dairy</b>	:	A commercial establishment that processes and distributes milk and milk products.
<b>Detergents</b>	:	Chemicals used for cleaning purpose.

<b>Disinfection</b>	:	The reduction of number of microorganisms to a safe level.
<b>Milk Silo</b>	:	Higher capacity insulated tanks used for storing milk.
<b>Sanitizers</b>	:	Chemicals /materials used for disinfection purpose.
<b>Rinse</b>	:	To wash with clean water

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## 15.9 SOME USEFULL BOOKS

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Farall Arthur W. (1967), Engineering for dairy and food products, Wiley Eastern Private Ltd. New Delhi.

BIS, New Delhi 11002. IS 2491:(1998), Food Hygiene – Hazard Analysis and Critical Control pont (HACCP) –system and guidelines for its application.

BIS, New Delhi 11002. IS 15000:(1998), Food Hygiene – General principles - Code of practice (second Revision),

De, Sukumar, (1980), Outlines of dairy technology. Oxford University Press, Delhi.

Newcomer, J.L., (1981),.Preventive maintenance manual for dairy industry, Venus Trading Company, P.O.Box 17, Anand 388 001, Gujrat, India,

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## 15.10 ANSWER TO CHECK YOUR PROGRESS

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Your answer should include following points:

### Check Your Progress 1

- 1)
  - i. Pre-rinse with clean, soft cool water.
  - ii. Circulate detergent solution.
  - iii. Rinse with cool water
  - iv. Sanitize by circulating hot water
- 2)
  - i. Dairy processing equipments like milk chiller, pasteurizer, tank/silo, milk piping circuit, evaporator etc. requires cleaning- in- place method for cleaning and sterilization.
- 3)
  - i. Water hardness compound like  $\text{CaCO}_3$  and milk stones are acid soluble and therefore to remove them acid circulation is required.

### Check Your Progress 2

- 1)
  - i. CIP system contains: detergent, water, acid and sanitizer tanks, heating' arrangements, temperature and pH control/indicating device, valves, filters, forward and return line circuit etc.
- 2)
  - i. Main two hypes are arrangements are employed:
    - Heating by steam through steam coil in the solution tanks.
    - Heating in plate heat exchangers.
- 3)
  - i. Complete automation works for maintaining temperature and concentration of solution, selection of CIP tank/equipment to be cleaned with programmed CIP for each solution circulation.

### Check Your Progress 3

- 1)
  - i. Milk pasteurizer after cleaning is circulated with hot water of 85 to 90 °C for 15 to 20 minutes for proper sterilization of plates and connected pipelines.



## Check Your Progress 4

## Cleaning-in-Place (CIP)

- 1)
  - i. Acid circulation should be followed by alkali circulation, to neutralize the acidic effect.
  - ii. Leakage of acid solution into milk stream may curdle the milk and therefore, before acid circulation, the milk side parts should be properly isolated by blanks or detached from the CIP lines..
- 2)
  - i. Cleaning of CIP spray balls periodically.
  - ii. Cleaning of filters
  - iii. Checking of control for high/low level, temperature and pH.