Chapter 10

Cleaning and Sanitation of Dairy Equipments, Clean-in-Place (CIP)

Objective

This chapter discusses the principles of cleaning and sanitation of dairy equipment. Cleaning in place (CIP) system is an integral part of any dairy or food processing plant. CIP system consists of equipment, pipes and automation systems that manage the circulation of cleaning solutions through the process equipment and piping network.

Introduction

Cleaning and sanitisation of pipes, fittings, dairy equipment, tanks etc is necessary to prevent:

- Accumulation and growth microorganisms in the equipment. Product will be contaminated by pathogens during processing.
- Development of foul smell in the equipment which will adversely affect the product quality.
- Corrosion of metal surface due to lactic acid.

CIP System

As the name suggest, cleaning is done in-place. It is a method of cleaning pipes, fittings, tanks, vessels, process equipments, etc without need for dismantling or disassembling.

After any processing operation the piping systems and process equipments must be properly cleaned. The deposits left after processing due to milk and milk product is known as “soil”. Soiled equipment surface allow bacteria to grow and cause contamination of milk. This can result in quality defects and the product will have limited shelf life. In some cases it may cause food poisoning. Therefore cleaning of equipments becomes necessary after use. Cleaning can be done in two ways:

a. Manual Cleaning: Requires dismantling of equipment for cleaning.

b. Cleaning in-place (CIP): CIP systems are designed for automatic cleaning without major disassembly and assembly work.

Advantages of CIP

- Reduces and eliminates the possibility of cross contamination.
- Good reproducibility of the cleaning process because the cleaning parameters are defined. Repeatable, validateable and controllable cleaning results.
- Does not require dismounting of equipment which saves time and reduces downtime of process equipment.
- Reduces labour requirement.
- The cleaning system can be automated and can be programmed for different cleaning cycles.
- Lower operating cost. Savings in energy and chemical costs.
- The cleaning solution can be reused.
- Reduce operator hazards associated with handling cleaning chemicals.
- Reduce wear-and-tear on equipment.
- Cleaning cycle reports/logs can be recorded.
- Uniform cleaning over all surfaces and conformity to cleaning requirements cleaning requirements.
- Reduction of potential operator interface error.
- Simple and easy operation through automatic controls and human machine interface.

Factors Affecting CIP Cleaning

The cleaning principle for CIP relies on application of suitable detergent or solvent at a suitable flow, pressure, temperature and concentration for sufficient period of time.

a. **Flow velocity:** For adequate cleaning of pipes and surfaces the velocity of the cleaning solution should be in the range of 1.5-3.0 m/s.

b. **Pressure:** Adequate pressure in CIP fluid circulation systems is necessary for reliable performance of spray devices. Pressure and fluid velocity are interdependent. CIP solution pressure is proportional to the square of its velocity.

c. **Temperature:** Cleaning efficiency greatly depends on the solution temperature. Very high temperature hardens the soil making it difficult to remove. Low temperature may reduce the cleaning efficiency. The operating temperature range is determined by process requirements, type of solution and its chemical activity.

d. **Cleaning Solution chemical concentration:** The concentration/strength of the cleaning solution and sanitizer must be maintained to ensure adequate cleaning. Too high concentration will be wastage of chemicals and add to cost. A lower concentration may not clean equipments and piping networks effectively.

e. **Cleaning time:** Cleaning time is the time in which the cleaning solution is in contact with the equipment or cleaning surface. Time of cleaning depends on the concentration of solution, solution quantity, temperature and nature of the milk soil (Hard/soft).

Sequence Operations of CIP Systems

A general sequence for CIP cleaning is as follows:

Water pre-rinse	:	Flushing to eliminate residues
Alkaline rinse	:	Alkaline detergents dissolve fats and proteins. Aids in cleaning where harder deposits have occurred.
Intermediate water rinse	:	To flush alkali solution.
Acid rinse:	:	Required for neutralizing the caustic remaining on the surfaces of the plant. Acidic detergents remove mineral deposits on the equipment surface.
Final water rinse	:	Cold water to flush residual acid solution

Methods

CIP systems can be classified in the following ways:

a. **Single use:** Cleaning solution is used once and it is drained after cleaning (Fig.10.1). Cleaning solution is not reused. Such systems are used for small units and equipments.

b. **Re-use:** If the equipment is not heavily soiled, the cleaning solution is re-used by adding more chemical concentrate as required (Fig.10.2).

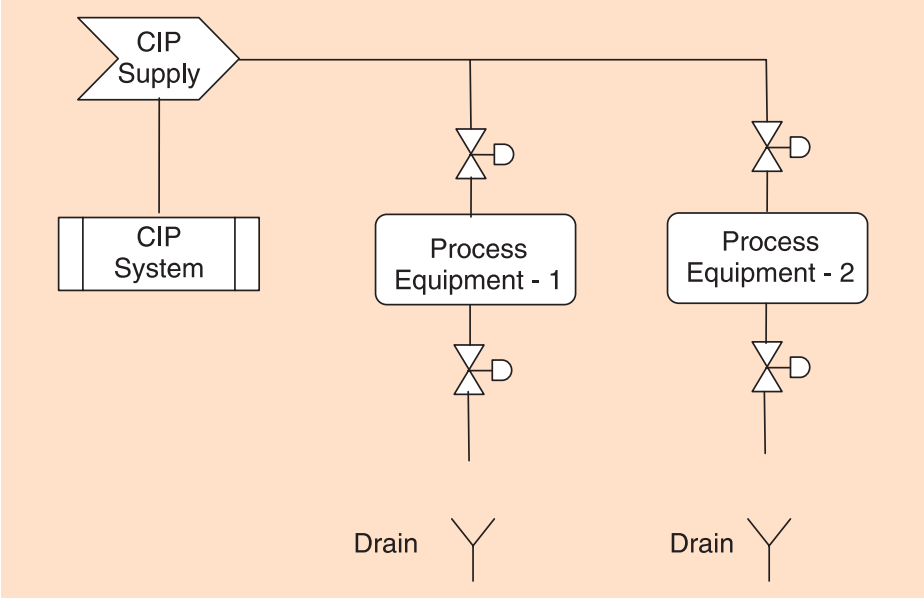

Fig.10.1. Single use CIP system

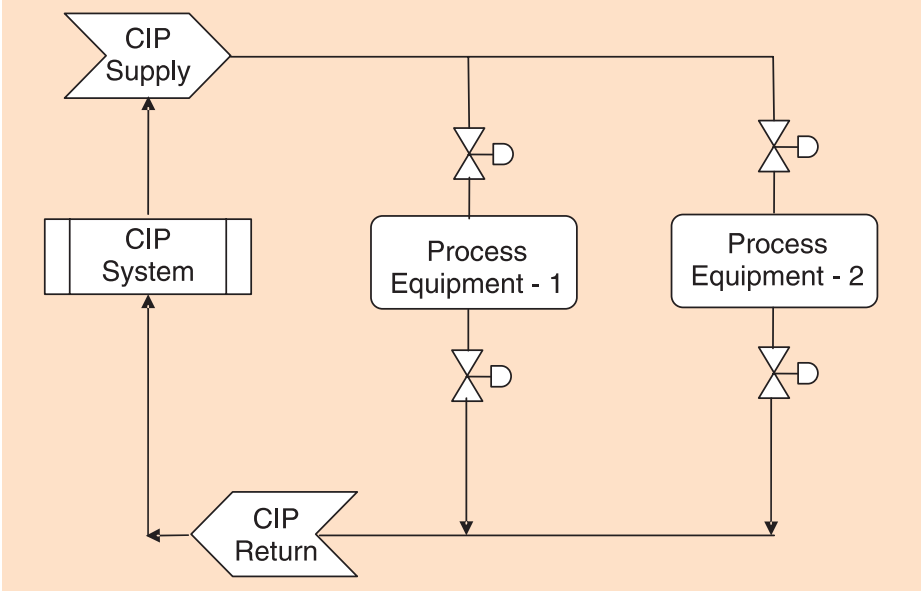

Fig.10.2. Re-use CIP system

Equipments

A CIP system for 1 lac litre per day dairy processing unit is shown in fig.10.3. A CIP Systems comprise of following components (Fig.10.4):

- Stainless steel tanks
- Plate heat exchanger for heating water and cleaning solutions
- Temperature sensors and temperature control system
- Chemical metering and dosing pumps
- Conductivity meter for chemical strength control
- CIP supply pump
- Supply pipeline
- Cleaning heads, spray devices for equipment cleaning
- CIP return pump
- Return pipeline
- Flow valves and routing valves
- Programmable Logical Control (PLC) and control system

Fig.10.3. CIP section

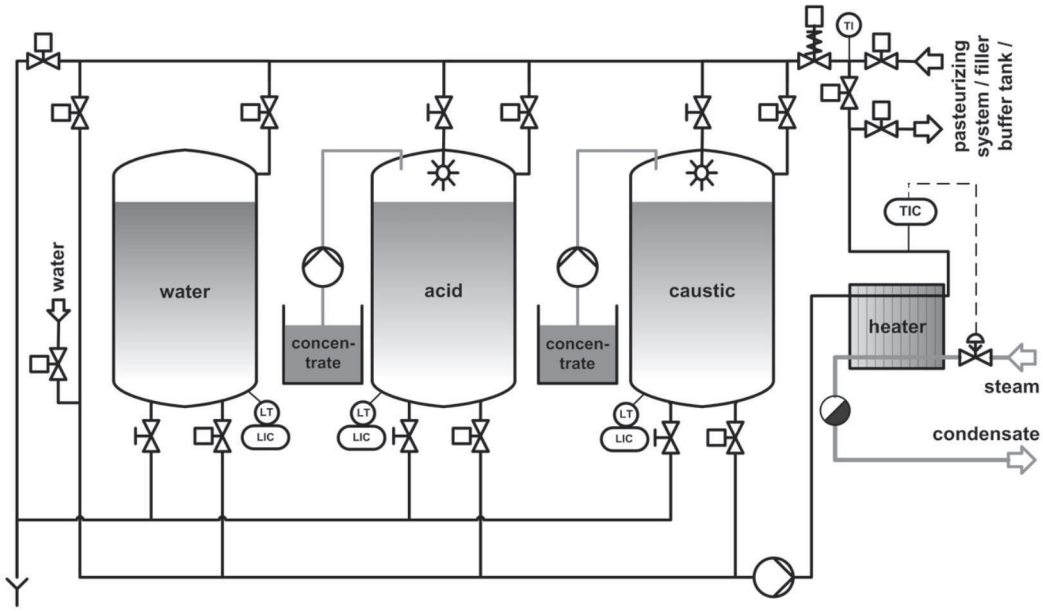

Fig.10.5. Components of a CIP system

Fig.10.5. Lye tank

Fig.10.6. Acid tank

Fig.10.7. Hot water tank

REVIEW QUESTIONS

1. Why cleaning and sanitation is required in a milk processing plant?
2. What are the differences between manual and CIP cleaning?
3. What are the advantages of CIP cleaning?
4. Briefly describe the factors affection CIP cleaning.
5. With a neat diagram differentiate single and re-use CIP systems.