# Technews

**National Dairy Development Board**

**For Efficient Dairy Plant Operation**

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# CONTROL OF POST PROCESS CONTAMINATION OF MILK

This bulletin includes technical and latest development on products, systems, techniques etc. reported in journals, companies' leaflets and books and based on studies and experience. The technical information on different issues is on different areas of plant operation. It is hoped that the information contained herein will be useful to readers.

The theme of information in this issue is **Control of Post Process Contamination of Milk**. It may be understood that the information given here is by no means complete.

***In this issue:***

# 1. INTRODUCTION

Raw milk received in dairy plants contain bacteria resulting mostly from the contamination during its handling and bacterial growth. A lot of these are harmful – these could be pathogenic or could be milk-spoiling bacteria – and therefore are unwanted. Milk is therefore pasteurized as soon as possible after milking, in which process not only all pathogens are destroyed, but most of other bacteria are also killed. This makes milk safe for human consumption and increases its shelf-life.

However, proper processing of milk alone is not adequate to ensure the safety and quality of final product, all the links in the subsequent 'milk chain' need to be properly managed. In the absence of this, a dairy plant runs the risk of unsafe and poor quality product with attendant disastrous results. Consider for example the following incidences:

* There was an outbreak of Staphylococcal enterotoxin poisoning due to contaminated processed milk of one dairy company in Japan in 2000. Over 11000 people were affected, with 165 requiring hospitalization. Infections were traced to one plant where a single valve in the production line had been inadequately cleaned[(1)]. The company suffered a loss of over Rs.500 crore (Euro 103 million)[(2)].
* In the USA, 29 outbreaks were recorded between 1993 and 1997 related to dairy products, of which 34% were caused by contaminated milk. A *Salmonella* spp. was isolated in three outbreaks, *Escherichia coli* in two outbreaks and one each due to *Campylotactor* and *Listeria*[(3)].
* A market survey of processed milk of 10 brands in India in 1999 reported high level of *E. coli* in milk of several brands[(4)].

* In an incident in USA in 1985, 16000 persons suffered salmonellosis due to drinking pasteurized low fat milk of 2 brands. The milk was found to be contaminated with *Salmonella typhimurium*. The contamination of milk occured due to cross-contamination with raw milk in the pasteurizer[5]. The plant has to be closed and products recalled.

These are only a few examples: many more have been reported, and many have remained unreported. Inadequately processed milk or recontamination cause poor quality and unsafe milk which cost the dairies heavy economic losses and loss of reputation.

Reasons of low quality and unsafe processed milk include inadequate pasteurization process or post-process contamination. In most of the cases of unsafe pasteurized milk, the reason found had been post-process contamination (PPC). Therefore, while it is important to ensure proper pasteurization of milk, it is equally important to take all precautions to avoid PPC. This issue of Technews outlines major reasons of PPC and their control measures.

## 2. COMMON RECONTAMINATING MICROORGANISMS

Pasteurized milk has been reported to be recontaminated with several types of microorganisms, spoilage-causing and/or pathogenic. Table 1 lists most common microbial hazards that have been implicated in pasterized milk.

**Table 1: Some microbial hazards identified in pasteurized milk**

| Microbial hazard | Reference |
|---|---|
| *Campylobacter jejuni*, *Listeria monocytogenes*, *Salmonella* spp., Staphylococcal enterotoxin, *Yersinia enterocolitica*, Shiga toxin-producing *E. coli* (STEC) | 3 |
| Gram-negative pychrotrophs | 6, 7 |
| Pseudomonads | 7, 8 |
| *Bacillus cereus* | 6, 7, 9 |

Recontamination of pasteurized milk with gram-negative pychrotrophic bacteria (GNP), responsible for spoilage of milk, has been reported to occur in filling step[6, 7]. Pseudemonads have been found to be the most frequently occuring bacteria in refrigerated, pasteurized milk[7, 8].

Gram-positive spores (GPS), such as *Bacillus cereus* spores, also recontaminate processed milk and are sometimes alone responsible for its spoilage[6,7,9]. The contamination sites could be dead ends, pockets and traps where bacteria can get stuck in the system in case the CIP system is ineffective.

Enteropathogenic *Escherichia coli* and *Salmonella* have been reported to be present in pasteurized milk due to recontamination [1, 3]. Likewise, *Campylobacter* spp., *Staphylococcus aureus* and *Listeria monocytogenes* have also been found in recontaminated milk[1, 3].

## 3. POST PROCESS CONTAMINATION ROUTES

Milk may be contaminated via a myriad of contact surfaces of processing and packaging equipment and plant environments (Figure 1). Milk residues on inadequately cleaned surfaces, tanks,

pipes and valves can support the survival and growth of microbial contaminants. Spores of *B. cereus* are very hydrophobic and will attach to the equipment surfaces where they may germinate and form biofilm at sites that are difficult to clean. Contamination of milk by *B. cereus* has been demonstrated in silos, pasteurizers, milk pipelines with bad welding and packaging machines. Very often recontamination has been found to occur during filling process by the rinsing water inside and around the filling machine[6]. Filling procedure is an open process and allows milk to come in contact with the surrounding air and with its aerosols; condensed water on the equipment may also find its way into the milk, and the packaging material might be contaminated[7].

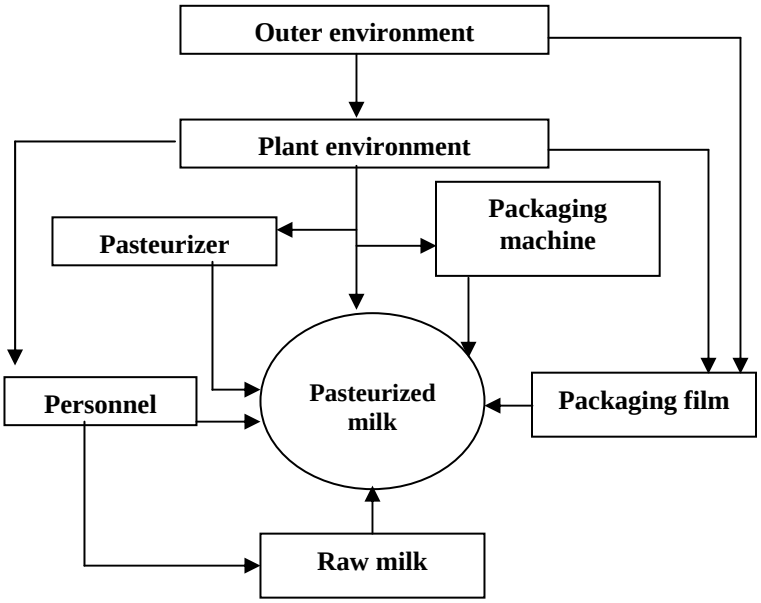


**Figure 1**: Possible routes of recontamination of pasteurized milk

Recontamination of milk could take place at various sites in equipment and pipework such as dead ends, pockets and traps[7] and mixing processed milk with the recycled processed milk received back from stores[2].

Modern pasteurizers are often complex, and although efficient, these do present possibilities of cross contamination of milk. Heat treated cooling milk is passed through regeneration and cooling water sections where it is separated by relatively thin plates from raw milk and chilled water, respectively. Should any of these plates leak to allow raw milk or chilled water access to pasteurized milk, there is a significant risk of recontamination of milk with pathogens or spoilage microorganisms.

Further, the cleaning-in-place (CIP) lines and other associated lines in the pasteurizer might, if incorrectly designed or installed, allow raw milk to by-pass the pasteurizer completely.

## 4. PRECAUTIONS AGAINST RECONTAMINATION

Prevention of recontamination of pasteurized milk is of major importance in production of pasteurized milk that is both safe and of satisfactory shelf-life. Some control measures against contamination of milk with specific pathogens are listed in Technews Issues 31 and 32. Modern equipment such as plate pasteurizers and filling machines are usually designed and constructed to minimize the possibility of the pasteurized product being contaminated, however, adequate precautions are required to be taken to ensure that post-process contamination does not take place. Some of the important precautions are elaborated below:

**1. Source: Plant environment**

**Pathway**: Usually indirect via contamination of equipment. Also possible via personnel and packaging.

**Precautions**: Eliminate contamination of pasteurized milk side of regenerator of pasteurizer by leakage etc. from raw milk and coolant sides. Correct environmental sanitation.

**2. Source: Equipment**

**Route**: Direct as following:

i) Contamination of equipment by raw-milk, coolant leaked in regenerator or cooling section, respectively, due to gasket failure, splits or pin, hones in pasteurizer plates, improper pipelines / valves arrangement.

ii) Contamination by stagnant milk or milk deposits at dead ends, valves, gaskets etc.

iii) Inadequate CIP and manual cleaning, where necessary, such as valves and sampling cocks; development of biofilms and colonization of milk contact surfaces by micro-organisms.

**Precautions**:

i) Vent interspace between seals to atmosphere to provide an immediate visual indication of gasket failure.

ii) Maintain a positive pressure balance, at least 0.5 bar (0.5 kg/sq. cm), between pasteurized milk and raw milk in the regeneration section.

iii) Ensure correct positioning of flow diverter and associated pipework to avoid contamination of pasteurized milk when forward-flow resumes after diversion.

iv) Restrict operating periods to 8 h.

v) Testing for corrosion cracks and pinholes by a lithium injection test twice a year.
vi) Visual inspection every day for back pressure control.
vii) Milk contact surfaces of pasteurizing plant should be fabricated from high grade stainless steel and polished by electro-polishing to avoid crevices and consequent entrapment of soil. Welds, joins etc. should be finished to the highest possible standard.
viii) Follow suitable cleaning and sanitization programmes for pasteurizer, storage tanks, silos etc.
ix) Extra cleaning in case of more than 3 days between processing runs.
x) Dismantling and inspection every 5 years.

**3. Source: Raw milk**

**Pathway**: Direct or indirect via contamination of plant environment, passive transfer or hands of personnel, etc.

**Precautions**:

i) Correct design of equipment and related pipework.
ii) Correct operation and maintenance of pasteurizer.
iii) Correct plant layout
iv) Control of personnel movement and avoidance of 'hands-on' operations involving milk or milk contact surface.

**4. Source: Personnel**

**Route:** i) Direct due to personnel suffering clinical illness or being chronic carrier of pathogens.
ii) Indirect due to introduction to plant of contamination from outside environment.

**Precautions:** i) Follow appropriate medical and exclusion policies.
ii) Ensure good personal hygiene and correct use of protective clothing and footwear (see Technews Issue 37).
iii) Prohibit raw produce such as eggs being brought into the plant by farmers or workers for sale to fellow workers.

**5. Source: Packaging**

**Route:** i) Failure to adequately sterilize the packaging film in the packaging machine.
ii) Contamination of packaging from plant environment, etc.

**Precautions:**
i) Ensure correct functioning of required ultra-violet light system so that the packaging film is properly sterilized.
ii) Protect packaging from contamination.
iii) Cleaning and disinfection of packaging machine and buffer storage tanks according to conformed procedures. Avoid rinsing with water during filling.
iv) Disinfection of specific machine parts by alcohol spraying.
v) Adherence to keep hygienic conditions during filling.
vi) Follow conformed procedures regarding start, stop and interruptions.
vii) Remove first 20 packs.

It is of particular importance to ensure that there are no cross-connections between raw milk equipment and piping and pasteurized product equipment and piping. CIP systems should be separate for raw milk equipment and processed milk equipment. It should be ensured that pipelines and valves cannot be arranged and/or fail in such a way that pasteurized product or pasteurized product lines could be contaminated.

It is critical to ensure that the flow diversion valve is correctly installed and operated so that under-processed milk is not carried forward. The operation of the flow diversion valve should be checked each time the plant is started up and the correct operation of the recorded pen assured.

Maintenance of the correct temperature and holding time for the process should be ensured. Recording thermometers should be checked daily against a calibrated mercury-in-glass thermometer and holding times validated annually.

Unnecessary product handling steps between processing and filling should be avoided. In addition, the lines leading to the filler should be designed for efficient cleaning-in-place. Packaging machines themselves should be designed with emphasis on cleanability and potential for contamination during filling.

The location of the filler is also important. It is undesirable to place a milk filler in the same room as an open cheese vat when the environment could contain significant bacterial load. It is a good practice if the filler is placed in a designated filler room that operates under specific white-room guidelines, i.e., filtered air, employee dress-code, etc. The packaging material should be stored in a clean and sanitary manner to avoid contamination (see Technews Issue 2, May-June 1996).

Finally, milk processing and filling operations should be carried out following good manufacturing practices (see Technews Issues 38 & 39).

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**Please send your letters to :**

Dr. N.N. Varshney
National Dairy Development Board
PB No.40
Anand 388001
Gujarat

Fax No. (02692) 260157
Email : nnv@nddb.coop