

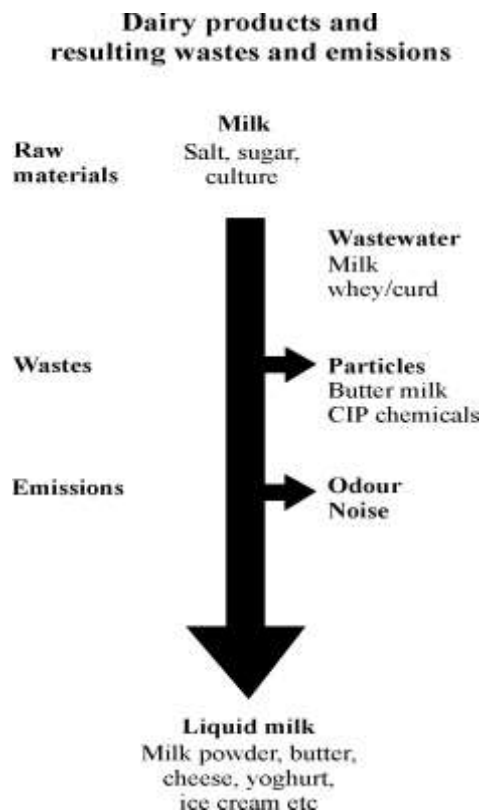
## WASTEWATER DISCHARGED FROM MANUFACTURING OF LIQUID MILK, BUTTER, GHEE AND MILK POWDER

### WASTE MINIMISATION

Under the *Industrial Waste Management Policy (Waste Minimisation) 1990*, premises which are subject to works approval require waste management plans incorporating waste minimization. Each dairy plant should therefore assess opportunities for reducing waste arising from its operations.

Waste reduction measures may include:

- ☐ reducing use of water
- ☐ reducing use of chemicals or substitution of mineral salts – for example, potassium in place of sodium compounds
- ☐ recycling water and chemicals
- ☐ recovery and reuse of product from first reuse
- ☐ reuse/reprocessing of off-spec material
- ☐ Recovering and reusing spilled raw materials and products.



### PROCESS CONTROL

#### Sources of waste

Dairy configuration and the products made affect the nature and concentration of dairy wastes. The amount of product lost depends on design and operational factors including:

- ☐ the range of process technologies in use
- ☐ the availability of adequate process monitoring, and plant and procedure alarms/interlocks
- ☐ the availability of automated operation – especially automated clean-in-place (CIP) systems and procedures
- ☐ the level of management and operator commitment, training and efficiency
- ☐ the level of routine equipment maintenance.

#### Best practice management options for waste

Plant	<ul style="list-style-type: none"> <li>• area and layout for works</li> <li>• noise attenuation works</li> </ul>
Processes	<ul style="list-style-type: none"> <li>• prevent spillages</li> <li>• purge lines</li> <li>• automate CIP systems</li> <li>• maintain equipment</li> <li>• recover and recycle waste (membrane technology)</li> <li>• monitor processes (alarms, interlocks)</li> <li>• new technology</li> </ul>
Personnel	<ul style="list-style-type: none"> <li>• waste management program</li> <li>• staff training</li> </ul>

### **Waste minimization strategies**

Most site losses come from activities associated with liquid handling and, to a lesser extent, with the discharge of air and solid waste. Some examples of avoidable losses are:

- ☐ leaking valves, pumps, pipelines or other fittings – the volume lost may not be large but the pollution load may be great
- ☐ spills from overflows, malfunctions and poor handling procedures – spills usually happen over a short period but the amount and the high concentration of milk or product lost may be a significant increase in the pollution load
- ☐ losses from processing and cleaning during the normal operation of plant and equipment
  - this includes the deliberate discharge of unwanted materials such as whey, spent cleaners and diluted product not thought to be worth recovering.

**Avoid, Reduce**



**Reuse, Recycle**



**Treatment**



**Dispose**

### **Suggested measures for reducing waste**

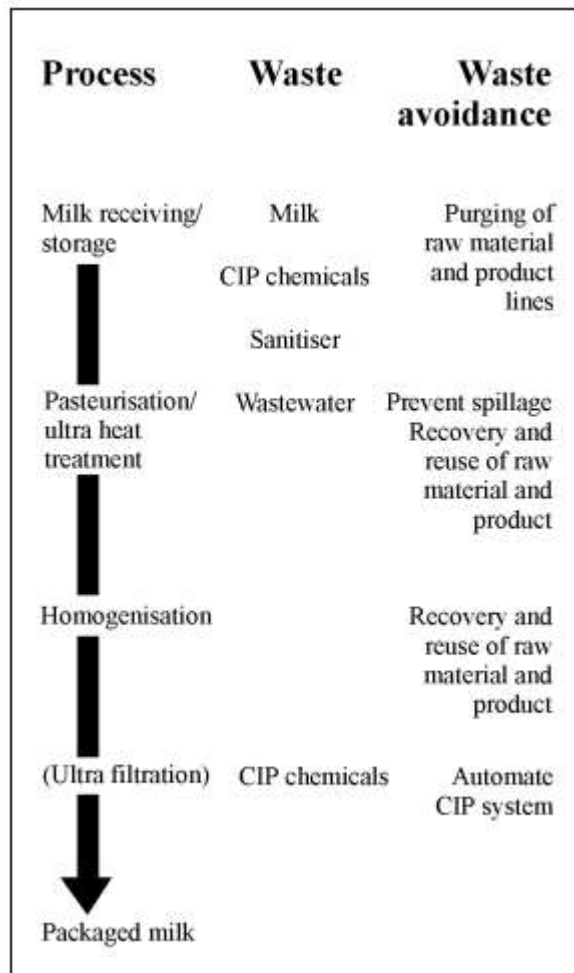
#### ***Liquid/packaged milk***

Liquid milk production may lead to the generation of odour, wastewater, noise and solid waste.

#### ***Butter and dried products***

Best practice involves processing the predominant by-products such as whey, buttermilk and skim milk, into high value products like skim milk powder (SMP), buttermilk powder (BMP), whey powder, whey protein concentrate and casein, rather than being used as low value animal feed/fertiliser or being dumped as waste.

Cream and butter are viscous and fatty and stick to equipment surfaces much more strongly than liquid milk, increasing the problem of removing residues. Hot water is an effective way to remove residual butterfat from cream processing and butter making equipment but the water temperature must not be too high (< 65 C) or there is the risk of “burning on” of some of the proteins. Whey should be dried where possible.



### Avoiding waste during liquid milk production

To initiate the process of cleaner production, a change in culture to waste minimisation is required. This involves moving from pollution treatment and control to anticipation and prevention of wastes.

Ways to prevent the build up of surface deposits include:

- ☐ minimisation of surface area
- ☐ prevention of build-up of milkstone deposits
- ☐ maintenance of butter churns
- ☐ correct preparation before filling
- ☐ not over-working the batch (this does not often happen with continuous butter making).

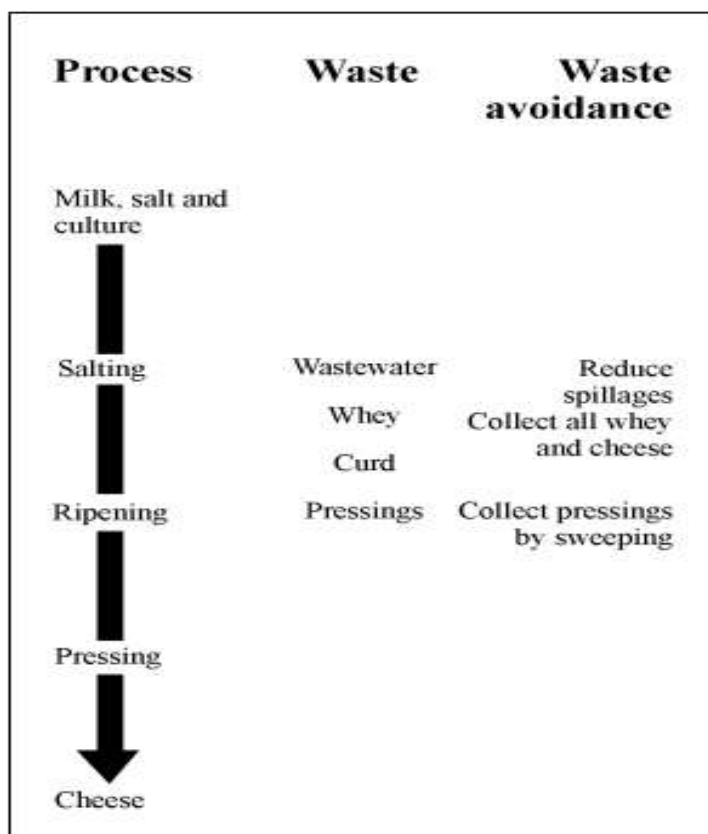
To avoid spills, buttermilk collection facilities should be large enough to hold all buttermilk discharged. Buttermilk should be dried or used as animal feed and solids recovered from butter wash water also may be sold as stock feed.

### **Cheese and dried products**

Making cheese generates a large volume of by- products such as whey.

Waste reduction can be achieved by:

- ☐ not overfilling cheese vats to stop curd loss
- ☐ completely removing whey and curds from vats before rinsing
- ☐ segregating all whey drained from cheese
- ☐ sweeping up pressings (particles)
- ☐ screening all liquid streams to collect fines.

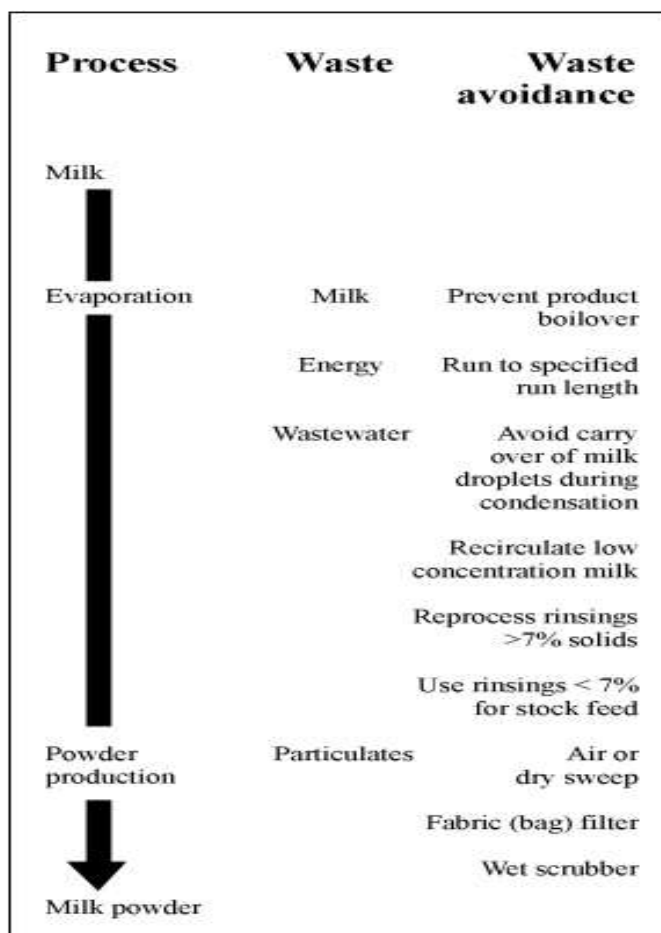


**Ways to avoid waste during cheese production**

## Evaporation and powder production

It is suggested that evaporators be operated to:

- ☐ maintain a liquid level low enough to stop product boil-over
- ☐ run to specified length – excessively long runs with higher than specified running rates lead to blocked tubes which not only produce high pollution, but are difficult and time-consuming to clean
- ☐ use effluent entrainment separators to avoid carry-over of milk droplets during condensation of evaporated water
- ☐ recirculate low concentration milk or other feed-stock until it reaches the required concentration
- ☐ process rinsings with 7% or more of solids before scheduled shutdowns, or evaporate them during the next run rather than discharging to the sewer
- ☐ minimise air emissions by using fabric filters or wet scrubbers.



## Ways to avoid waste during powder production

## **Components of dairy wastewater**

The major contaminants in dairy processing wastewater are milk solids that contain milk fat, protein, lactose and lactic acid. Other minor constituents include sodium, potassium, calcium and chloride.

Organic wastewater strength is measured by either BOD or COD. Typical process wastewater has a biochemical oxygen demand (BOD<sub>5</sub>) of about 2,000 mg/L and dissolved solids concentration of 1,800 mg/L. BOD<sub>5</sub> is a measure of the amount of organic matter that is able to be biologically oxidised over a five day period.

Whey has a BOD<sub>5</sub> concentration of 30,000- 40,000 mg/L. Where the whey is not used as a by-product but is discharged as effluent, it will increase the BOD level of wastewater and cause treatment and disposal problems. Whole milk has a BOD of 100,000 mg/L.

Although the throughput of milk in dairy plants is generally increasing, the technologies available for reducing and recycling wastes means that the volume of water used and wastewater generated is significantly less in modern plants.

## **Wastewater treatment and disposal**

Because of the highly seasonal nature of milk production, during peak periods the volume of wastewater generated at dairy plants may be several times greater than during off peak periods.

The batch nature of many processes, and intermittent operations such as cleaning and sanitizing, also means a wide daily variation in wastewater flows and quality.

Options for dairy factory wastewater include:

- ☐ treatment to a suitable standard for reuse or recycling
- ☐ discharge to local authority sewers under a trade waste agreement (with pre-treatment as necessary)
- ☐ appropriate treatment and land discharge wherever practicable and environmentally beneficial

### ***Reuse and recycling***

Many dairy plants have technologies in place for recovering wastewater and/or condensate (from production of milk powder) for reuse in the dairy plant. Reuse and recycling can considerably decrease the volume of mains water required to operate the plant and also reduce the cost of both mains water and wastewater disposal. Fats, milk solids and minerals can also be recovered from wastewater and recycled – either at the dairy plant or off- site. Cleaning chemicals can also be recovered and reused on site.

### ***Treatment and discharge to land***

Dissolved salts contained in dairy plant wastewater can adversely affect soil structure if wastewater is used to irrigate land. Wastewater can also leach into underlying groundwater and affect its quality.

Dairy plants should maximise the recovery, recycling and reuse of acids and alkali to minimize the dissolved salts and sodium levels in the wastewater. High salt levels affect the type of vegetation that grow. Over-irrigation may cause the underlying water table to rise, resulting in further deterioration of surface soils and vegetation.

### ***Discharge to sewer***

Even if there is a local sewage authority that will accept wastewater, the volume and organic load of wastewater from just one dairy factory during peak season may well exceed the township's domestic waste. This may overload the sewage treatment plant, cause odours and give rise to poor effluent quality. Domestic wastewaters have a BOD<sub>5</sub> concentration of about 250 to 300 mg/L but in peak season a large dairy factory could be discharging two megalitres of wastewater at BOD<sub>5</sub> of 2,000 mg/L each day – the additional load on a sewerage plant is equivalent to an extra 16,000 persons

### **Components of a wastewater system**

#### ***Segregation***

Clean stormwater should be separated from contaminated stormwater and discharged directly into stormwater drains. Waste streams from the plant should also be segregated – for example, whey can be reused to produce whey powder or stockfeed.

Spent cleaning solutions should be separated from other wastewater streams as they can be treated to recover cleaning agents. Highly saline wastewater should also be discharged separately to an evaporation pond where the salts can be recovered and recycled.

#### ***Equalisation and pH control***

A balance tank or pond will even out variations such as pH and temperature.

Alternative pH control can be achieved by using spent acid and alkali cleaners to neutralize each other.

#### ***Fat removal***

Coarse milk solids should be removed by screening. Fats can constitute up to 50% of the organic load. Its recovery is therefore significant in any treatment process. Dissolved air flotation is a very effective method of separation.

#### ***Removal of organic load***

Organic load can be reduced by **physical methods** – such as **microfiltration, reverse osmosis and flotation techniques** – or by **biological treatments** – **such as activated sludge systems, trickling filters and anaerobic digesters**. Lagoons, land irrigation and grass filtration systems can also reduce organic loads but reduction will occur at a slower rate than the previous methods. Best practice management of the waste stream may include removal of product before treatment.

## ***Biological processes***

### ***Activated sludge***

A highly effective method for treatment of dairy plant wastewater is the oxidation ditch. This is a development of the extended aeration process where aeration, settling and withdrawal of effluent all takes place in the same tank. The oxidation ditch process is characterised by a long retention time and low net sludge yield. This type of treatment lends itself to biological nitrogen removal.

### ***Trickling filters***

The best trickling filters have a free passage of air to prevent the generation of odours but are sensitive to high or low pH which may result in killing the biomass.

### ***Lagoons***

Highest quality wastewater and low odour generation can be achieved in aerated lagoons which use floating aerators to force oxygen input and resemble activated sludge systems.

## ***Advanced treatment for reuse***

### ***Membrane filtration***

This process has the potential for **acid and alkali** recovery and recycling. Best quality wastewater is obtained by pumping effluent through porous media containing millions of tiny pores. The media area is regularly cleaned by high pressure backwash using water and/or air.

### ***Reverse osmosis***

The removal of dissolved solids is best achieved by the passage of water through a semi-permeable membrane that restricts the **movement of salts**. This process for the desalination of wastewater is based on the osmotic pressures on either side of the membrane.

### ***Land irrigation***

In inland areas, treated wastewater can be either sprayed on the land or applied by flood irrigation using laser levelling and a ridge and furrow system. Grass filtration allows a greater application rate than irrigation and grass filtration systems generally are intended as a refining phase in the overall treatment system. In these cases, the majority of the BOD will have been removed by other means.

### ***Emergency storage***

High strength waste spills can be directed to small dams which have been built to prevent the treatment process from turning anaerobic.