Dairy Industry

Industry Description and Practices

The dairy industry involves processing raw milk into products such as consumer milk, butter, cheese, yogurt, condensed milk, dried milk (milk powder), and ice cream, using processes such as chilling, pasteurization, and homogenization. Typical by-products include buttermilk, whey, and their derivatives.

Waste Characteristics

Dairy effluents contain dissolved sugars and proteins, fats, and possibly residues of additives. The key parameters are biochemical oxygen demand (BOD), with an average ranging from 0.8 to 2.5 kilograms per metric ton (kg/t) of milk in the untreated effluent; chemical oxygen demand (COD), which is normally about 1.5 times the BOD level; total suspended solids, at 100–1,000 milligrams per liter (mg/l); total dissolved solids: phosphorus (10–100 mg/l), and nitrogen (about 6% of the BOD level). Cream, butter, cheese, and whey production are major sources of BOD in wastewater. The waste load equivalents of specific milk constituents are: 1 kg of milk fat = 3 kg COD; 1 kg of lactose = 1.13 kg COD; and 1 kg protein = 1.36 kg COD. The wastewater may contain pathogens from contaminated materials or production processes. A dairy often generates odors and, in some cases, dust, which need to be controlled. Most of the solid wastes can be processed into other products and by-products.

Pollution Prevention and Control

Good pollution prevention practices in the dairy industry include:

- Reduction of product losses by better production control.
- Use of disposable packaging (or bulk dispensing of milk) instead of bottles where feasible.
- Collection of waste product for use in lower-grade products such as animal feed where this is feasible without exceeding cattle feed quality limits.
- Optimization of use of water and cleaning chemicals; recirculation of cooling waters.
- Segregation of effluents from sanitary installations, processing, and cooling (including condensation) systems; this facilitates recycling of wastewater.
- Use of condensates instead of fresh water for cleaning.
- Recovery of energy by using heat exchangers for cooling and condensing.
- Use of high-pressure nozzles to minimize water usage.
- Avoidance of the use of phosphorus-based cleaning agents.

Continuous sampling and measuring of key production parameters allow production losses to be identified and reduced, thus reducing the waste load. Table 1 presents product losses for a well-run dairy.

Odor problems can usually be prevented with good hygiene and storage practices. Chlorinated fluorocarbons should not be used in the refrigeration system.

Target Pollution Loads

Since the pollutants generated by the industry are very largely losses in production, improvements in production efficiency (as described in the previous section) are recommended to reduce pollutant loads.

Table 1. Product Losses in the Dairy Industry
(percent)

Operation	Product losses		
	Milk	*Fat*	*Whey*
Butter/transport of skimmed milk	0.17	0.14	n.a.
Butter and skimmed milk powder	0.60	0.20	n.a.
Cheese	0.20	0.10	1.6
Cheese and whey evaporation	0.20	0.10	2.2
Cheese and whey powder	0.20	0.10	2.3
Consumer milk	1.9	0.7	n.a.
Full-cream milk powder	0.64	0.22	n.a.

n.a. Not applicable.
Note: Data are expressed as the percentage of the volume of milk, fat, or whey processed.

Wastewater loads are typically 1–2 cubic meters per metric ton (m^3/t) of milk processed. The plant operators should aim to achieve rates of 1 m^3/t or less at the intake of the effluent treatment system. The BOD level should be less than 2.5 kg/t of milk, with a target of 1–1.5 kg/t. The BOD level from butter and cheese production should be less than 2 kg/t of product.

Treatment Technologies

Pretreatment of effluents consists of screening, flow equalization, neutralization, and air flotation (to remove fats and solids); it is normally followed by biological treatment. If space is available, land treatment or pond systems are potential treatment methods. Other possible biological treatment systems include trickling filters, rotating biological contactors, and activated sludge treatment.

Pretreated dairy effluents can be discharged to a municipal sewerage system, if capacity exists, with the approval of the relevant authority.

Odor control by ventilation and scrubbing may be required where cheese is stored or melted. Dust control at milk powder plants is provided by fabric filters.

Emissions Guidelines

Emissions levels for the design and operation of each project must be established through the environmental assessment (EA) process on the basis of country legislation and the *Pollution Prevention and Abatement Handbook,* as applied to local conditions. The emissions levels selected must be justified in the EA and acceptable to the World Bank Group.

The guidelines given below present emissions levels normally acceptable to the World Bank Group in making decisions regarding provision of World Bank Group assistance. Any deviations from these levels must be described in the World Bank Group project documentation. The emissions levels given here can be consistently achieved by well-designed, well-operated, and well-maintained pollution control systems.

The guidelines are expressed as concentrations to facilitate monitoring. Dilution of air emissions or effluents to achieve these guidelines is unacceptable.

All of the maximum levels should be achieved for at least 95% of the time that the plant or unit is operating, to be calculated as a proportion of annual operating hours.

Air Emissions

Odor controls (such as absorbents/biofilters on exhaust systems) should be implemented where necessary to achieve acceptable odor quality for nearby residents. Fabric filters should be used to control dust from milk powder production to below 50 milligrams per normal cubic meter (mg/Nm^3).

Liquid Effluents

The effluent levels presented in Table 2 should be achieved.

Ambient Noise

Noise abatement measures should achieve either the levels given below or a maximum increase in

Table 2. Effluents from the Dairy Industry
(milligrams per liter, except for pH, temperature, and bacteria)

Parameter	*Maximum value*
pH	6 –9
BOD	50
COD	250
TSS	50
Oil and grease	10
Total nitrogen	10
Total phosphorus	2
Temperature increase	≤ 3°C[a]
Coliform bacteria	400 MPN/100 ml

Note: Effluent requirements are for direct discharge to surface waters. MPN, most probable number.
a. The effluent should result in a temperature increase of no more than 3° C at the edge of the zone where initial mixing and dilution take place. Where the zone is not defined, use 100 meters from the point of discharge.

background levels of 3 decibels (measured on the A scale) [dB(A)]. Measurements are to be taken at noise receptors located outside the project property boundary.

	Maximum allowable log equivalent (hourly measurements), in dB(A)	
Receptor	*Day (07:00–22:00)*	*Night (22:00–07:00)*
Residential, institutional, educational	55	45
Industrial, commercial	70	70

Monitoring and Reporting

Monitoring of the final effluent for the parameters listed above should be carried out at least once per month, or more frequently if the flows vary significantly.

Monitoring data should be analyzed and reviewed at regular intervals and compared with the operating standards so that any necessary corrective actions can be taken. Records of monitoring results should be kept in an acceptable format. The results should be reported to the responsible authorities and relevant parties, as required.

Key Issues

The key production and control practices that will lead to compliance with emissions guidelines can be summarized as follows:

- Monitor key production parameters to reduce product losses.
- Use disposable packaging (or bulk dispensing of milk) instead of bottles, where feasible.
- Design and operate the production system to achieve recommended wastewater loads.
- Recirculate cooling waters.
- Collect wastes for use in low-grade products.

Sources

Economopoulos, Alexander P. 1993. *Assessment of Sources of Air, Water, and Land Pollution: A Guide to Rapid Source Inventory Techniques and Their Use in Formulating Environmental Control Strategies.* Part 1: *Rapid Inventory Techniques in Environmental Pollution.* WHO / PEP / GETNET / 93.1-A. Geneva: World Health Organization.

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