UW DAIRY ALERT!

A Technical Update for
Dairy Product Manufacturers

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Wastewater volume—How do we compare?

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From time to time we get requests from dairy plant operators for information on wastewater analysis and discharge volumes for other plants in order to compare and evaluate their own plant operation. Over the past 10-15 years, dairy plants in Wisconsin have faced new regulations on phosphorus, chlorides, and ammonia nitrogen and they have adjusted their operations to meet these new limits. Since more plants are required to routinely monitor their discharges, they are aware of the biological loads emitted from their plants. They have also become aware of product losses, not only the value of lost product but also treatment costs to remove those components from wastewater discharges. To aid dairy plant operators, we have reviewed current literature and reports to develop this review of the current environmental status of dairy plants.

Wastewater volume

In 1971, EPA conducted an industry-wide survey to help establish categorical standards for various processing industries. Their first reported wastewater volumes for fluid milk plants, placed in general categories of types of management, are listed in Table 1.

Table 1.

Product	Gal. of wastewater per 1000# of milk processed	Level of management practice
Milk	48.2	Excellent
Milk	626.6	Poor
Milk & butter	96.4	Good
Butter/powder	301.2	Fair

Source: Harper and Blaisdell, 1971.

Table 2.

Plant type	Gal. of wastewater per 1000# of milk processed*
Milk receiving station	48.1
Butter plant	96.2
Cheese plant (including evap. whey)	168.3
Milk powder (skimmed)	54.1
Fluid milk	240.4

* Converted to gal/1000# of milk processed from G.O.Z. standards after Jan. 1, 1974.
Source: Baltjes, 1978.

In the 1970s, international dairy plants were also facing environmental concerns with process wastewater. The Netherlands set the following discharge standards for wastewater volume from Dutch dairy plants listed in Table 2.

Typical wastewater volumes from dairy plants in New Zealand, Table 3., were reported in 1978 by Marshall (1978):

Table 3.

Plant type	Gal. of wastewater per 1000# of milk processed*
Butter plant	168.7
Cheddar cheese plant	289.1
Cheddar cheese plant	228.9
Cheddar & Colby plant	132.5

* Converted to gal/1000# of milk processed from m3 H2O/m3 of milk.
Source: Marshall, 1978.

Over the past 15-20 years, Wisconsin dairy plants have been systematically dealing with increased environmental standards at the same time that there has been an increased emphasis on eliminating potential pathogens in the plant with better sanitation. Plants have been working on minimizing waste to recover more resources and improve plant efficiency. At the same time, they may have increased cleaning and sanitation procedures to maintain a proper plant environment. To determine the impact that these environmental changes may have had on dairy plant wastewater volumes, we reviewed the recent literature to obtain more current wastewater volume figures.

In 1998, Danalewich et al. (1998) reported on a survey of process wastewater from 15 Midwestern cheese plants. The plants processing capacity ranged from 1.1 to 2.0 million lb. of milk per day. Their wastewater volumes from cheese manufacturing and whey processing operations ranged from 81.9 to 227.3 gal. of wastewater per 1000# of milk processed. Six of the 15 plants would have met the 1974 Dutch cheese plant standard of less than 168.3 gal. of wastewater per 1000# of milk processed. In 2003, Baskaran et al. (2003) reported on wastewater from 6 Australian dairy plants. Wastewater volumes for those plants are listed in Table 4.

Table 4

Plant type	Gal. of wastewater per 1000# of milk processed*
Milk powder, anhydrous milk fat	43.0
Milk powder, cheese	169.3
Milk powder	117.5
Milk powder, butter, UHT milk	93.0
Milk powder, butter, cheese	143.0
Milk powder	94.2

* Converted to gal/1000# of milk processed from vol. H2O/vol. of milk.
Source: Baskaran et al., 2003.

Wastewater volumes still seem to be somewhat variable between plants, although that may be dictated by sewer standards and waste treatment plant pretreatment requirements that certain dairy plants may be required to meet. Depending on the region of the country and source of water, water conservation may be as important as product recovery and waste minimization for plant operating costs. Water reuse may become more important in future years as potable water supplies become more limited.

Biological waste load

In the 1971 EPA survey of the dairy industry, values for biological load (Biochemical Oxygen Demand –BOD) were also reported and classified by the general categories of types of management. See Table 5.

Table 5.

Product	# of BOD per 1000# of milk processed	Level of management practice
Milk	0.3	Excellent
Milk	7.8	Poor
Milk & butter	0.9	Good
Butter/powder	3.0	Fair

Source: Harper and Blaisdell, 1971.

In the international dairy plants, pollution load was also of concern to the environmental regulatory agencies. In the 1970s, the Netherlands set the following discharge standards for wastewater volume from Dutch dairy plants, listed in Table 6.

Table 6.

Plant type	# of BOD per 1000# of milk processed*
Milk receiving station	0.13
Butter plant	0.34
Cheese plant (including evap. whey)	0.54
Milk powder (skimmed)	0.43
Fluid milk	1.59

* Converted to # BOD/1000# of milk processed from G.O.Z. standards after Jan. 1, 1974, assuming avg. yield for product.
Source: Baltjes, 1978.

Listed below in Table 7 are typical biological loads in wastewater from dairy plants in New Zealand.

Table 7.

Plant type	# of BOD per 1000# of milk processed*
Butter plant	4.49
Cheddar cheese plant	2.68
Cheddar cheese plant	1.98
Cheddar & Colby plant	2.20

* Converted to gal/1000# of milk processed from kg BOD/m3 of milk. Source: Marshall, 1978

In the 1998 report on the survey of process wastewater from 15 Midwestern cheese plants, Danalewich et al. (1998) reported biological loads of 0.99 to 3.06 #BOD/1000 # of milk processed with an average of 1.81 # BOD/1000 # of milk processed. None of the Midwest cheese plants would have been able to meet the Dutch standard for biological load.

Milk losses

Since over 90% of the biological wastewater load from dairy plants comes from the loss of milk and milk components, concentration of efforts to reduce the cost of wastewater treatment must be aimed at reducing those milk losses. Not only is the plant losing the value of the lost product, but they are then paying treatment costs to remove those milk components from the wastewater stream. BOD of each type of milk component is shown in Table 8.

Table 8.

Milk Constituent	# of BOD per # of milk component
Lactose	0.65
Lactic acid	0.64
Milk fat	0.89
Milk proteins	1.03
Casein	1.04

Source: Harper and Blaisdell, 1971

Measurement of plant efficiency and product recovery has been ongoing for a number of years in dairy plants. In 1950, Pfautz (1950) reported in a survey of 118 Pennsylvania dairy plants processing fluid milk that the average milk loss throughout the process was 2.35% of the milk and 1.61 % of the milk fat. The New Zealand Dairy Research Institute (1976) reported milk and milk fat losses from several different types of dairy plants in Table 9.

Table 9.

Product	% Milk loss	% Milk fat loss
Butter/buttermilk	1.8	1.1
Cheese (mechanized)	4.7	2.9
Cheese (partially mechanized)	4.0	3.0
Cheese (traditional)	5.1	1.5
Multi-product	9.9	1.4

Source: Anon., 1976.

Baltjes (1978) reported the following standard pollution milk fat and protein losses for Dutch dairy plants, listed in Table 10.

Table 10.

Product	% Milk fat loss	% Milk protein loss
Fluid milk	1.0	1.8
Butter/powder	0.2	0.62
Cheese	0.2	0.3

Source: Baltjes, 1978

Carawan et al. (1979) reported milk losses averaging 2.14% and milk fat losses of 3.30% for a North Carolina multiproduct dairy plant. The latest figures available are from the IDF Guide for Dairy Managers on Wasteage Prevention in Dairy Plants and are listed in Table 11.

Table 11.

Product	% Milk fat loss	% Milk protein loss
Butter	0.12	NR*
Anhydrous milk fat	0.30	NR
Cheddar cheese		
Sweet whey	5.80	3.17
Salt whey	1.27	0.18
Stock food	0.11	0.12
Wastewater	0.50	0.22
Brined cheese		
Sweet whey	7.0	5.0
Stock food	0.05	0.05
Wastewater	0.50	0.50

* NR = not reported.
Source: Hale et al., 2003.

Conclusion

Over the past 15-20 years, environmental regulations governing dairy plants have continuously been tightened. Dairy plants have instituted waste reduction programs and have made a conscious effort to know their water usage and product recoveries. Most plants have been striving to meet their immediate environmental standards in discharge permits or sewer standards that limit acceptance of effluents discharged to waste treatment plants. Some plants may have specific management programs designed to meet environmental standards for phosphorus, chlorides or fat, oils and greases (FOG). Environmental audits should be conducted periodically in plants to ensure that operations are in control and product losses are held to a minimum.

Comparisons can be made with industry averages but each plant's environmental program should be designed for that respective plant's operations. As potable water supplies be come more restricted in the future, dairy plants will need to evaluate potential areas for water reuse and water conservation. The most profitable dairy plants will be those with the best management of resources, whether they are raw materials, ingredients or utilities.

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