Water usage, Waste Water and Biogas Potential within the Dairy Manufacturing Sector

Introduction

Due to food safety and quality requirements hygiene levels must be very high in all food and drink operations, a significant volume of water is therefore used for cleaning and manufacturing purposes.

It is not unusual for a dairy manufacturing site to use 200m^3 or more of water per day, with close to 98% of this water usage being fresh water of drinking water quality.

Depending on the type of production 40% to 90% the water ends up as wastewater together with 0.5-3% of the milk intake reported as milk loss or measure as COD in the wastewater.

Dairy wastewater, de-sludge from wastewater plants and milk interfaces are all potential sources for biogas production

Water usage

Water used within the dairy manufacturing sector must be of drinking water quality in order to keep a high level of hygiene and avoid microbial, chemical and physical contaminations.

The graph below shows the areas where water may be used at a dairy manufacturing site but a site specific water survey is always recommended as large variations can be seen depending on the type of production as well as the process design and equipment as shown in Table 1.

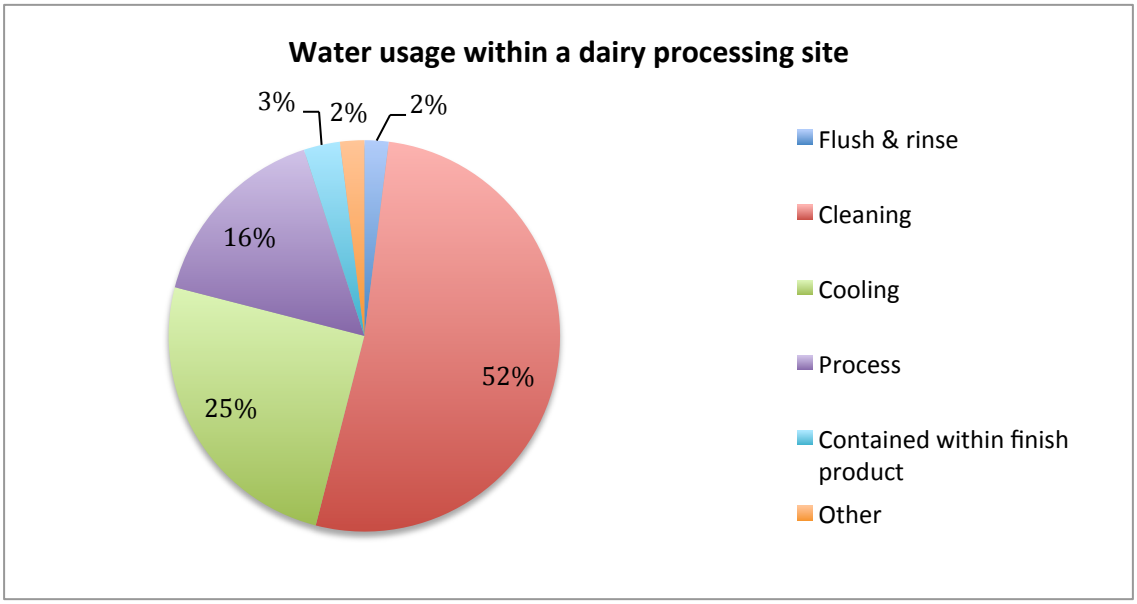

Figure 1 Breakdown of water usage for a dairy manufacturing site. Environment Agency, DK 1994

Table 1 shows water:milk ratios for respectively the Nordic Dairy Industry and the European Dairy Industry – these date were reported within the BREF report for the Food&Drink Sector, Aug 2006.

Table 1 Water usage per raw material intake for different types of product.

	Milk and yoghurt	Cheese	Milk powder, Cheese and/or liquid products
Nordic Council 2001	0.6 – 4.1 l/l	1.2- 3.8 l/l	0.69-6.3 l/l
European Dairy Association 2002	0.8 – 25 l/kg	1-60 l/kg	1.2 – 60 l/kg

But even here the data shows a significant variation between the manufacturing sites represented in each group. This reflects both the diversity in manufacturing process the as well as the efficiency of the technology used.

More recent data have been collected by **FoodEfficiency** covering 25 Danish dairy processing activities, presented in Table 2 where various Environmental Key Performance Indicators have been calculated for different types of production.

Table 2: Environmental Key Performance Indicators as per raw material intake, Danish Dairy Sites, 2010/11

Utility	Liquid Dairy products	Cheese products	Milk and Whey Powder
Water L/kg intake	0.6 - 2.7	1.0 - 4.0	0.4 - 1.0
Electricity kwh/ kg intake	0.042-0.128	0.055 - 0.20	0.04 - 0.07
Heat kWh/kg intake	0.032-0.315	0.08 - 0.40	0.18 - 0.30
Total energy kWh/kg intake	0.075-0.420	0.135-0.525	0.25 - 0.35
Wastewater L/ kg intake	0.5-2.5	1.05 - 3.6	0.45 - 3.0
Wastewater L /L water	0.5-2.5	0.8 - 1.15	0.7 - 3.1

Once used for rinsing, cleaning and cooling the water is discharged as wastewater together with product interfaces.

In order to reduce the total water usage water identified process water and product interface streams can be collected for further treatment, e.g. by using membrane technology where by water can be reclaimed for alternative usage or reused, depending on treatment and quality requirements.

Wastewater

For a dairy manufacturing site with a daily water usage of 200m3 water the volume of wastewater can be from 100 to 600m3 depending on product and production type. Dairy wastewater will often undergo one of following treatments;

- Flow and pH balancing followed by discharge to municipality wastewater treatment plant
- Fat and protein removal by flotation or filtration technology followed by discharge to municipality wastewater treatment plant, or
- Wastewater treatment with discharge to local waters

Little investment is required for flow and pH balancing, discharge costs will often be calculated on basis of the volume and concentration of the wastewater, measured as COD (mg/l). After flow and pH balancing the COD concentration will be between 2000 and 5000mg/l

Investments are required for fat and protein removal and a disposal route for fat and protein is required, e.g. for biogas manufacturing. The pre-cleaned wastewater will contain a COD concentration of 500-1000mg/l and must still be discharged to the local wastewater plant.

For a full wastewater treatment plant significant investments are required as well as high operational costs due to the requirement for daily manning. There are little or no discharge costs for discharge of cleaned water to local waters (with a COD <75mg/l), but a disposal route for the sludge from the wastewater plant is required, e.g. for biogas.

Biogas

By-products from the dairy manufacturing industry provide a significant potential for biogas production. Alone Region Midt in Denmark no less than 13 biogas plants exists producing 50mio m3 natural gas/year. 2/3 of the feed for these plants come from local food manufacturing sites.

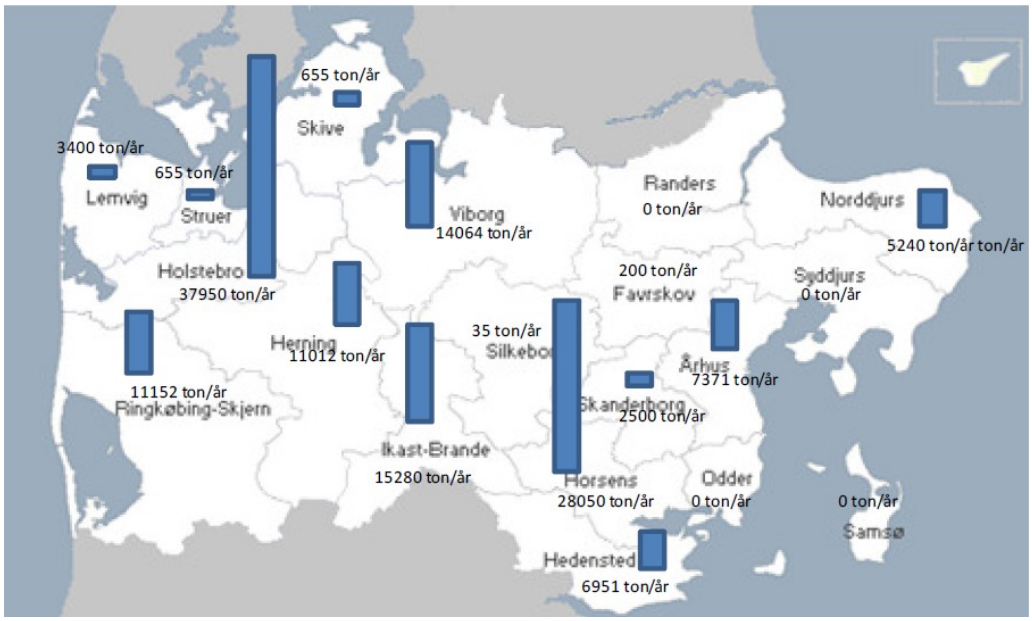

Fig. 2 Biogas plants in Region Midt and their annual biomass intake, Denmark, 2012.

In general dairy products and by-products are rich in lactose, fat and protein and therefore an easily digestable in biogas plants. Potential waste steams from dairy manufacturing plants can be;

- Separator de-sludge
- Milk interfaces
- Cheese whey
- Returned products
- Products with quality problems
- Sludge from wastewater pre-treatment plants
- Sludge from wastewater plants

However in order to optimize the biogas production the average dry-matter of the feed to the biomass plant should be above 14%. It is therefore suggested that dairy bi-products are mixed with other products such as;

- Woodchips,
- Solid dung and liquid manure,
- Deep bedding,
- Straw, and
- Waste from sugar, corn or potato processing

The Danish dairy company Arla Foods is currently part of a collaboration building a new biogas plant. The plant will produce biogas on the basis of a supply of 550,000 tons of biomass per. years of which 25% will be sourced from its dairy manufacturing sites. The biogas plant is estimated to produced approx. 31 m^3 million. biogas per. years.