RESOURCE CONSERVATION BY THE APPLICATION OF CLEANER PRODUCTION TOOLS IN MOTHER DAIRY

By

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DEPARTMENT OF CHEMICAL ENGINEERING
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Major Project

Submitted in partial fulfillment of the requirements

For the degree of

Master of Technology in Chemical Engineering
(Environmental Process Design)

By

Vipin Rishiwal
(04MCH007)

Guide
Prof. Vipul N. Shah

NIRMA UNIVERSITY
INSTITUTE OF TECHNOLOGY

DEPARTMENT OF CHEMICAL ENGINEERING
Ahmedabad 382481
May 2006

CERTIFICATE

This is to certify that the Major Project entitled "**Resource Conservation By The Application Of Cleaner Production Tools In Mother Dairy**" submitted by **Mr. Vipin Rishiwal (04MCH007)**, towards the partial fulfillment of the requirements for the degree of **Master of Technology in Chemical Engineering** (**Environmental Process Design**) of Nirma University of Science and Technology, Ahmedabad is the record of work carried out by him under my supervision and guidance. In my opinion, the submitted work has reached a level required for being accepted for examination. The results embodied in this major project, to the best of my knowledge, haven't been submitted to any other university or institution for award of any degree or diploma.

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Examiner

Examiner

Date of Examination

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ABSTRACT

In the words of a Dairy CEO,

For water use

In 1986, Grade A dairies in the USA processed over 60 billion pounds of products. They used about 9.3 billion gallons of milk to make these products. If the average plant used 4 gallons of water to process each gallon of milk, total water use for that year by the Grade A dairy industry exceeded 37.2 billion gallons. Some plants now use less than 1 gallon of water per gallon of milk processed. If all dairy plants could **save 3 gallons of water per gallon of milk** processed, **savings** would amount to approximately **28 billion gallons** of water enough to **supply** a city of **200,000 people for a year.**

For waste Load

The average Grade A dairy plant produces 5 pounds of $B0D_5$ per thousand pounds of milk processed. The resulting annual BOD_5 load from dairy processing is almost 400 million pounds. Some plants discharge as little as 1 pound of BOD5 per thousand pounds of milk processed. If all plants reduced their discharge to this level, about **320 million pounds** of **BOD_5** could be **eliminated,** which is the same amount discharged annually from a city of **5.2 million people.**

With the above background and insight, the presented work was initiated with an aim to realize the savings in terms of pollution & resource consumption in a real multi-product dairy (**Mother Dairy, Gandhinagar**) as to upgrade the overall status of the organization as well as to serve the society by cutting down the pollution from the industry.

Along the lines of **Cleaner Production,** the concept of **Waste minimizing practices** has been used for the objective of resource conservation in a multi-product dairy. The presented work is an effort to bring in the importance of resource conservation to the industries, the applicability of CP tools to dairy industries and the importance of waste minimization in any endeavor of this kind.

With the commitment of the dairy management and the intervention of academicians the scenario of resource consumption has improved a lot which can be understood with the following figures:

- Recovery of about **200 kg fat/day**
- Reduction of pollution load by **270 kg/day BOD**
- Monetary saving of about **72 lakh Rs. /Year**

With these concrete results from the project the dairy management is quite inspired and is willing to achieve excellence at every front. The dairy almost has achieved **1:1 ratio** in milk received and water consumed and is still working for excellence. At the organic load front, the picture is a bit gloomy but their efforts are definitely on with the philosophy of **reducing the pollution at the source** with the help of Cleaner Production.

So as a conclusion, **a target** on the basis of observations and analysis has been furnished along with the recommendations for the **continuous improvement** of the organization. In addition to this a strategy is been proposed to bolster the MIS of MDG and a dialogue has been initiated to continue this project as an endeavor to aim at **ZERO DISCHARGE**. The Dairy management has responded very positively to the proposal and it is already in process.

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ABBREVIATIONS

CP – Cleaner Production
MDG – Mother Dairy Gandhinagar
KLPD – Kilo liter per day
LLPD – Lakh liter per day
LLPM – Lakh liter per month
SNF – Solid not fat
COD – Chemical oxygen demand
BOD – Biochemical oxygen demand
CIP – Cleaning in place
APS – Aseptic packaging system

CHAPTER 1 BACKGROUND

1.1 STATUS OF DAIRY INDUSTRY

1.1.1. INDIAN DAIRY IN GLOBAL CONTEXT

India is the 2nd largest producer of milk, and the milk is the second largest agricultural commodity after rice in terms of its contribution to agricultural gross domestic product. Having achieved self-sufficiency in milk production, the emphasis now is shifting towards value addition to improve the share of dairy products in global trade, which hitherto has remained negligible. Most of the Indian dairy products are not export competitive. The lack of competitiveness is often attributed to inefficiency in the processing industry. Further, the international diary markets however remains distorted due to protectionist policies followed in the developed world. Under such a situation India has an undaunted task to make its presence felt in the world market. In order to improve the processing efficiency, dairy industry was de-licensed in 1991 with the expectation that it would encourage private investment and improved technology in this sector. Subsequently, other reforms in the form of creation of export promotion zones, reduction in tariffs and custom duties on machinery etc. were introduced. [1]

Being signatory to WTO agreement, it becomes mandatory for India to open the dairy sector to the world market. The import of dairy products was de-canalized during 1994. All the milk products except malted foods are covered in the category of industries for which foreign equity participation up to 51 per cent is automatically allowed. Moreover, the capital goods can be imported freely if it is financed through foreign equity. Ice- cream industry, which was earlier reserved for manufacturing in the small-scale sector, has now been de-reserved. Licensing procedures have been simplified. Quantitative Restrictions (QRs) on all dairy products were removed from April, 2001. Initially, the import tariffs for most of the dairy products were reduced considerably with zero duty for skim milk powder and whole milk powder. However, India renegotiated the WTO bound rates with the duty of 15 per cent on milk powder up to 10,000 tons under the Tariff Rate Quotas (TRQ) and will attract the import duty of 60 per cent outside the TRQ. [1]

World milk production

In 2001 India became the global leader with the production volume of 84 million tons of milk in a year.

Dairy animals

Although achieving similar production volume India keeps 3 times the cattle than USA. In addition, 94 million buffalo contribute to milk production in India.

Dairy farm structures

The vast majority of Indian dairy animals are kept in farms of 2 to 8 animals. While the average Indian dairy herd consists of 2 animals, the average farm in USA keeps 88 dairy cows and in New Zealand an average of 236 dairy cows.

Milk yields

- A new Zealand cow produces 5 times as much as an Indian cow
- A US cow produces 10 times as much as an Indian cow

These vast differences in milk production can be attributed to various factors such as, genetics, feeding, management, technology etc about which a great amount of scientific knowledge exists.

Milk production per capita

Due to its high human population and low milk yield India has a very low value of milk production per capita. The opposite holds for New Zealand where population is very less and milk yield is very high as compared to India.

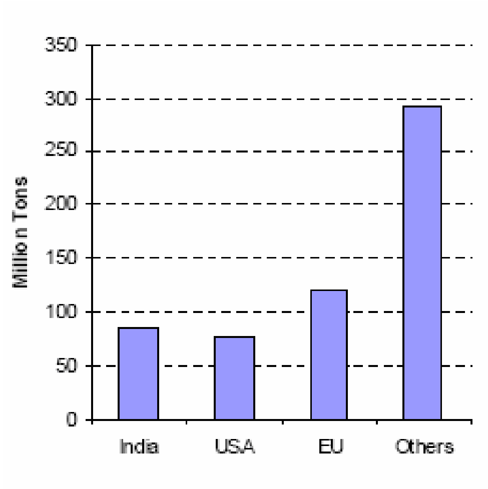

Figure: 1 Milk production per country [2]

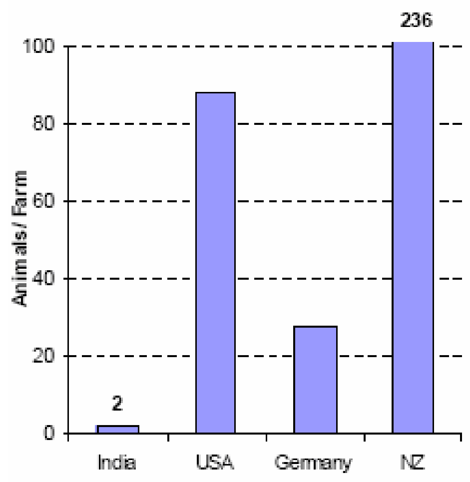

Figure: 2 Dairy farm size [2]

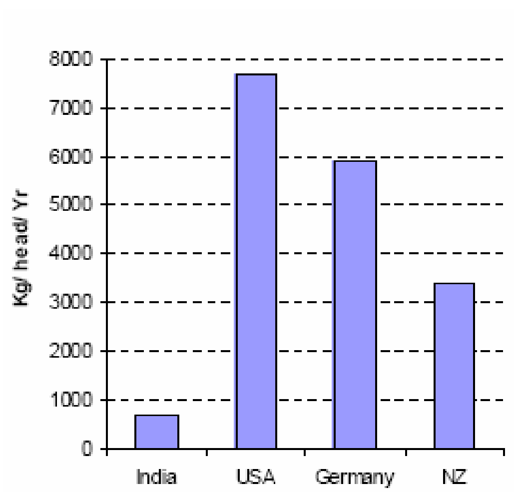

Figure: 3 Milk yields per milch animal [2]

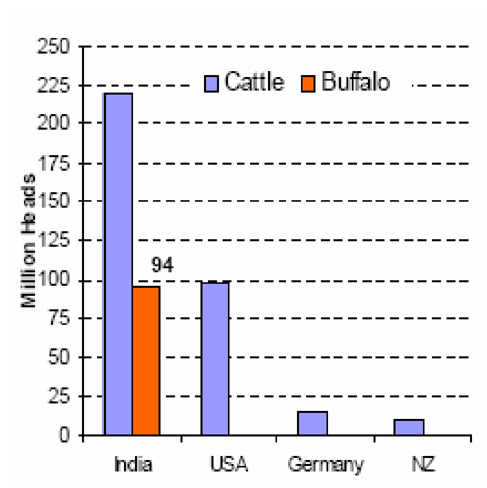

Figure: 4 Number of live animals [2]

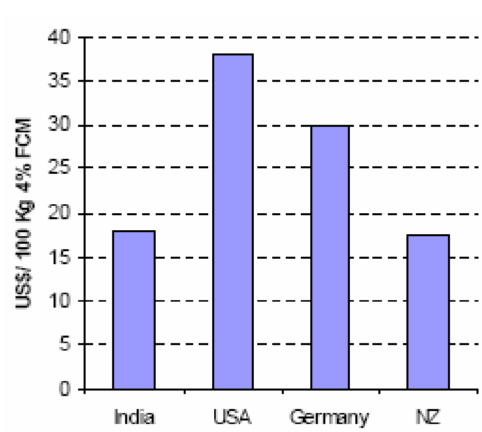

Figure: 5 Farm gate price [2]

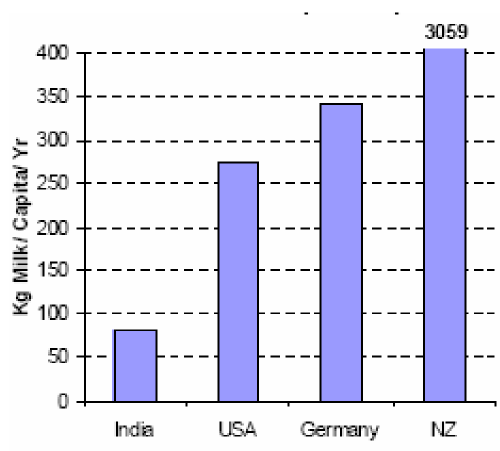

Figure: 6 Milk production per capita [2]

1.1.2. STATUS OF DAIRY IN INDIA

National milk production [2]

India has made tremendous progress in milk production over the last two decades. In 1980-81, the milk production was 32 million tons, which increased to 81million tons in 2000-01. The per capita availability increased from 128 gms / day during 1980-81 to 214 gms / day during 1999-2000. Milk and milk products are income elastic in nature, and the demand for milk and milk products is to increase considerably over the next two decades. Milk, in India, is largely consumed as raw milk; about 60 percent of the milk output is consumed as raw. The rest is consumed in the form of various traditional milk products such as Dahi, Makhan, Khoa, Burfi, Gulabjamum etc. Over time though the number of organized manufacturing units increased from 279 in 1981-82 to 835 in 1999-2000, but only about 15 percent of the milk output undergoes commercial processing. The rest of the processing takes place at the household level.

The tremendous progress in milk production can be attributed to an enabling policy environment. A dairy development program known as **'Operation Flood'** was initiated in 1970 by the National Dairy Development Board (NDDB) with the aim to provide market access to the producers through development of cooperatives, and improve milk availability to the urban consumers in the major cities. The successful implementation of the 'Operation Flood' made the country self-reliant in milk production. However, all these developmental efforts took place in a protected policy environment, that is, the dairy industry was reserved for cooperatives until recently. Imports of dairy products were canalized through NDDB. Further, the commercial import of milk products also stopped from 1975-76 onwards. On the whole, the dairy industry was protected from private and foreign competition. As a part of the market reforms program, the dairy industry was de-licensed in 1991. The government enacted Milk and Milk Products Order (MMPO) in 1992 to regulate the production and maintain the quality of milk and milk products. The order was amended in March 2002, which lays stress on hygiene, sanitation, quality and food safety standards in the dairy sector. The registered units are no longer allotted the designated milk sheds. The amendment is expected to ease the entry of potential private enterprises in this sector. **[2]**

Development of milk production in India

- 2001 shows a production volume 130% of that in 1995.
- Interestingly, milk production from Buffalo, local cattle and crossbred cattle has experienced almost identical growth rates.

Regional shares of milk production in India

- Northern region has experienced a decline
- East region share has been increased
- Northern and southern region have maintained their positions

Development of daily milk yields

Between 1995 and 2000 daily milk yield has increased at a faster rate.

- For local cattle (+ 34 percent)
- For buffalos (+ 17 percent)
- For crossbred cows it has declined by 5 percent for the same period

Development in number of dairy animals

- Local cattle remain same
- Buffalo increased by 10 percent
- Crossbred cows increased by 50 percent

Milk price development

- The milk price has seen a decline from 22 to 18 US$/ 100 Kg FCM i.e. about 17% and the reason perhaps is the devaluation in Indian rupee.

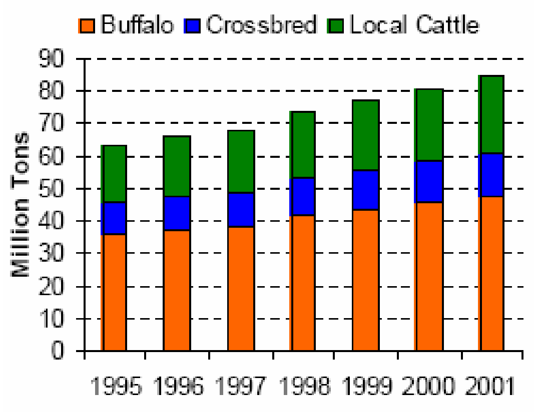

Figure: 7 Milk productions [2]

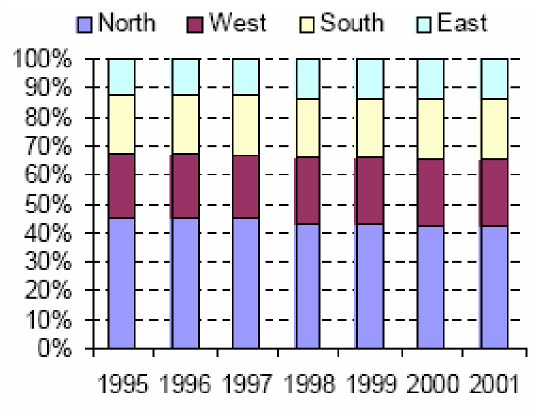

Figure: 8 Regional milk productions [2]

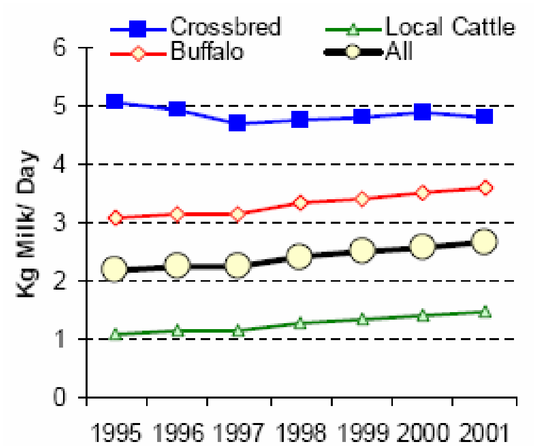

Figure: 9 Daily milk yields [2]

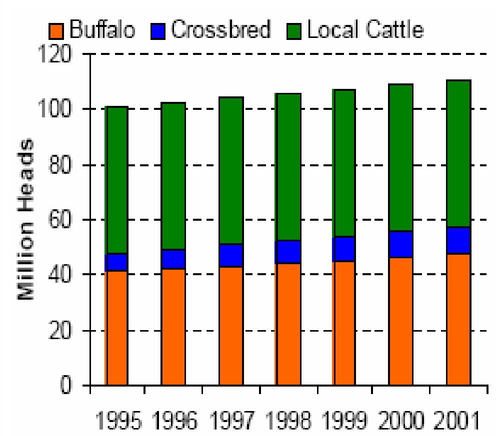

Figure: 10 Number of milch animal [2]

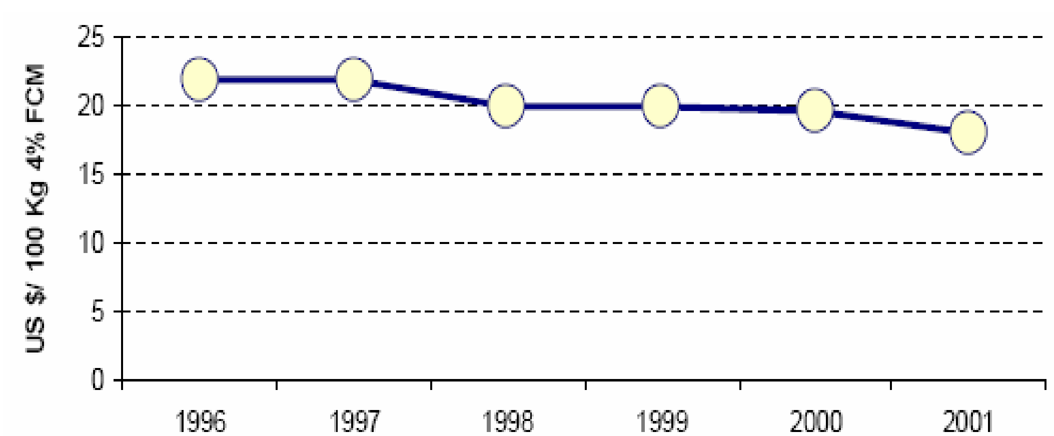

Figure: 11 Milk price developments [2]

1.2. ENVIRONMENTAL ISSUES OF DAIRY AND THE EFFORT REQUIRED

The reduction in loss of product, water, and energy in dairy food plant operations is a goal toward which all dairy plants must strive to improve products, minimize impact on the environment and to meet Federal, State, and local regulations. This report described herein is directed primarily toward the areas where pollution prevention and resource conservation opportunities exist and it also brings in the concept for the development and operation of a waste control program in a dairy food plant. Dairy plant losses can be categorized as:

(a) Unavoidable, and
(b) Preventable.

Unavoidable losses are related to plant and process design and are primarily associated with cleaning operations. Preventable losses, usually over 50% of all losses, are those that can be eliminated by good operational practices. A waste control program aims at eliminating preventable losses and applying engineering improvements to equipment and process design to minimize the level of unavoidable losses.

The given information can also be used for development of waste control programs in other food industry plants. Experience shows that the approaches outlined can reduce product losses, organic waste loads, water loss and energy wastage by at least 50% in an average plant, when fully supported at all levels of management and operational personnel. The success of the program depends upon the motivation of people and continued attention to a well-organized program. All too often a control program is instituted, works very well in the beginning then, because of lack of continued attention, the waste situation rapidly deteriorates.

Waste control is an important aspect of resource management control and an essential part of dairy food plant operations. Waste control *(quantity control)* should be recognized as equal in significance to quality control. Where plant size warrants, the quantity control task warrants the full-time assignment of at least one person to the waste control program. Only when this area is given full time attention can long-term benefits be achieved. In most situations, the time spent by one or more individuals will be repaid to the company over a period of a year.

1.2.1 Environmental Effects of Dairy Wastes

The major pollutant and waste discharged from dairy plants is organic material. This is milk diluted with water discharged as wastewater. When dumped untreated into a stream or river, organic material is decomposed by microorganisms in the river. When breaking down the organic pollution, the microorganisms consume oxygen in the water. That action can degrade the water by depleting its oxygen content. Oxygen depletion, in turn, can have a catastrophic impact on life in the water body for fish or which must have dissolved oxygen to survive. When all oxygen in a water body is used up, as frequently happens, the decay of organic matter continues without the oxygen. As a result, noxious gases such as hydrogen sulfide and methane are produced and result in an odor much like that of a septic tank. The measurement of pollutants that consume oxygen in water is called biochemical oxygen demand, or BOD. Water with high BOD contains a large amount of decomposed organic matter. Another pollutant in dairy plant discharges is suspended solid waste, such as coagulated milk, particles of cheese curd, and in an ice cream plant, pieces of fruit and nuts. This type of pollutant is called total suspended solids, or TSS.

These solids discolor and cloud the water. They impair photosynthesis in the aquatic plants. They can settle on the bottom and become sludge beds and further deplete the waters' oxygen content. As the sludge decomposes, it gives off gases that are toxic to aquatic life. Raw wastes from the dairy plant contain excessive amounts of organic materials and suspended solids. These wastes must be treated before they can be discharged into a river or stream. The major dairy industry water pollutants, organic materials and suspended solids, can be treated successfully either by a municipal treatment facility or by an onsite plant operated by the dairy. Other identified pollutants in dairy plant wastes that may be of concern include phosphorus, nitrogen, chlorides, and heat. Another consideration is the pH of to other aquatic animals and on plants. In some situations, whey creates a problem for municipal treatment plants. This usually occurs when the whey discharge is a significant portion of the load to the municipal plant.

The wastewater characteristics for dairy plants are extremely variable. The data of many authors who have studied dairy operations indicate that wastewater parameters may have a range as wide as following:

BODS - 500 to 5,000 mg/L

SS - 400 to 3,500 mg/L

Fat - 200 to 3,000 mg/L

Flow - 0.5 to 20 kg per kg of product

1.3. ECONOMIC CONSIDERATIONS

Water and sewer charges for larger dairy processing plants can exceed $50,000 per month. Water and sewer charges are estimated at less than $2,000 a month for the average dairy plant. Surcharges can approach $5,000 to $10.000 per month for the same average dairy plant. Waste treatment plants for a large dairy processing plant might cost $1.5 to $2.5 million to meet rigid effluent standards. A strong economic incentive to build such waste treatment plants is the cost of water, sewers, and surcharges – estimated at more than 1 /3 of a cent per gallon for a well-operated dairy plant. Plants without adequate waste control programs might pay bills for water, sewer and surcharges which exceed 1 cent per gallon of processed products. When the average dairy plant makes only 2.6% profit based on sales, and when more than 2/3 of a cent per gallon of profit can be gained from waste control, then control of wastes becomes economically attractive to dairy plants. The increase in cost of energy also relates to waste control programs. Much of the product that is lost during processing has been pumped, chilled, heated, and homogenized. Because each of these cleaning processes require great quantities of warm or hot water, the control of waste also controls energy losses.

1.4. AVAILABILITY OF BENCHMARKS:

Various benchmarks are available in the literature in form of specific consumption of water, energy with respect to milk received or product formed in dairy industry and as a matter of fact they work as a guide to the industries to evaluate their performance as far as their resource consumption & pollution generation is concerned and it also helps in deciding the practically reachable targets for resource consumption & pollution generation for a given dairy industry in different section as well as for whole organization.

There are a few sample benchmark data for dairy industry's water consumption which are on the basis of milk received.

Table: 1, [4] plant water use per unit product

Area	Average water used (gal/ 1000 lb product)
Processing plants	432
Offices	2.4
Refrigeration shops	1.2
Garage	10.8
Total	448.4

Table: 2, [4] average water use per unit product

Product	Average water used (gal/ 1000 lb product)
Fluid products	205
By products (Cottage Cheese)	1982
Frozen products	2146
Total products	434

As it is clear from the above table that these benchmark values are the work of the industry people and researchers from various dairy plants for a given technology and specification of products so when some other plant with the same technology and products needs to evaluate itself in terms of water consumption or resource status, the above values can directly be used to give them the status of resource utilization in the considered plant.

CHAPTER 2 ABOUT CLEANER PRODUCTION

2.1 GENERAL

2.1.1 Cleaner Production

Cleaner Production is an approach to environmental management that aims to improve the environmental performance of products, processes and services by focusing on the causes of environmental problems rather than the symptoms. In this way, it is different to the traditional ‘pollution control’ approach to environmental management. Where pollution control is an after-the-event, ‘react and treat’ approach, Cleaner Production reflects a proactive, ‘anticipate and prevent’ philosophy.

Cleaner Production is most commonly applied to production processes by bringing about the conservation of resources, the elimination of toxic raw materials, and the reduction of wastes and emissions. However it can also be applied throughout the life cycle of a product, from the initial design phase through to the consumption and disposal phase. Techniques for implementing Cleaner Production include improved housekeeping practices and procedures, process optimization, raw material substitution, new technology and new product design.

The other important feature of Cleaner Production is that by preventing inefficient use of resources and avoiding unnecessary generation of waste, an organization can benefit from reduced operating costs, reduced waste treatment and disposal costs for wastes and reduced liability. Investing in Cleaner Production, to prevent pollution and reduce resource consumption is more cost effective than continuing to rely on increasingly expensive ‘end-of-pipe’ solutions. There have been many examples demonstrating the financial benefits of the Cleaner Production approach as well as the environmental benefits.

2.1.2. Implementing a Cleaner Production assessment

This guide contains information to assist the reader to undertake a Cleaner Production assessment at a dairy processing plant. A Cleaner Production assessment is a systematic procedure for identifying areas of inefficient resource consumption and poor waste management, and for developing Cleaner Production options.

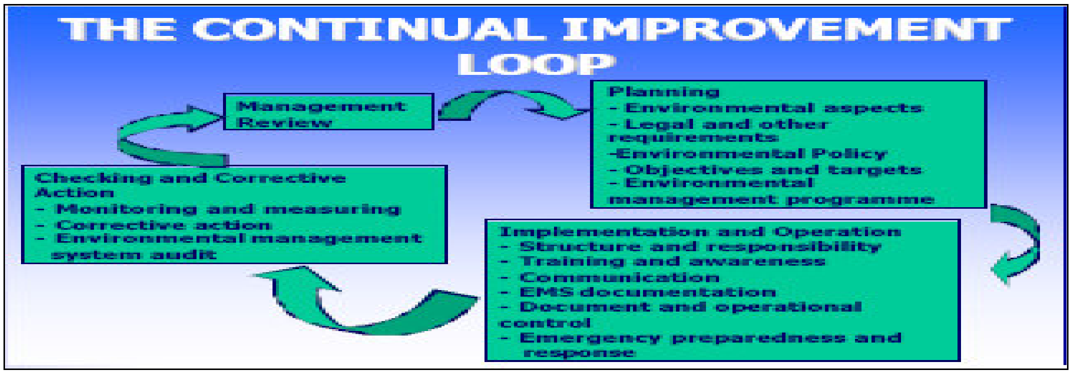

Figure: 12, PDCA cycle

The methodology described here is based on that developed by UNEP and UNIDO, and consists of the following basic steps:

- Planning and organizing the Cleaner Production assessment;
- Pre-assessment (gathering qualitative information about the organization and its activities);
- Assessment (gathering quantitative information about resource consumption and waste generation and generating Cleaner Production opportunities);
- Evaluation and feasibility assessment of Cleaner Production opportunities;
- Implementation of viable Cleaner Production opportunities and developing a plan for the continuation of Cleaner Production efforts.

It is hoped that by providing technical information on known Cleaner Production opportunities and a methodology for undertaking a Cleaner Production assessment, individuals and organizations within the dairy industry will be able to take advantage of the benefits that Cleaner Production has to offer.

2.2 OBJECTIVE

The main objective of this project is the resource conservation by the application of CP tools in Mother Dairy and in turn to help the company to improve its environmental performance**.**

2.2.1 Cleaner Production - Key Elements

Analysis of the efforts during the last decades demonstrates a clear evolution in the general attitude of governments and industry regarding protection of the environment in a positive sense. This is perhaps due to the development of win-win strategies, such as Cleaner Production. [5]

2.2.2 Cleaner Production describes a preventative approach to environmental management.

It is neither a legal nor a scientific definition to be dissected, analyzed or subjected to theoretical disputes. It is a broad term that encompasses what some countries/institutions call eco-efficiency, waste minimization, pollution prevention, or green productivity, but it also includes something extra.

2.2.3 Cleaner Production refers to a mentality

How goods and services are produced with the minimum environmental impact under present technological and economic limits.

2.2.4 Cleaner Production does not deny growth,

It merely insists that growth be ecologically sustainable. It should not be considered only as environmental strategy, because it also relates to economic considerations.

In this context, waste is considered as a 'product' with negative economic value. Each action to reduce consumption of raw materials and energy, and prevent or reduce generation of waste, can increase productivity and bring financial benefits to enterprise.

2.2.5 Cleaner Production is a 'win-win' strategy.

It protects the environment, the consumer and the worker while improving industrial efficiency, profitability, and competitiveness.

The key difference between pollution control and Cleaner Production

It is one of timing. Pollution control is an after-the-event, 'react and treat' approach. Cleaner Production is a forward-looking, 'anticipate and prevent' philosophy.

2.3. The definition of Cleaner Production by UNEP [5]

Cleaner Production is the continuous application of an integrated preventive environmental strategy to processes, products, and services to increase overall efficiency, and reduce risks to humans and the environment. Cleaner Production can be applied to the processes used in any industry, to products themselves and to various services provided in society.

For production processes,

Cleaner Production results from one or a combination of conserving raw materials, water and energy; eliminating toxic and dangerous raw materials; and reducing the quantity and toxicity of all emissions and wastes at source during the production process.

For products,

Cleaner Production aims to reduce the environmental, health and safety impacts of products over their entire life cycles, from raw materials extraction, through manufacturing and use, to the 'ultimate' disposal of the product.

For services,

Cleaner Production implies incorporating environmental concerns into designing and delivering services.

2.4. Methodology of Cleaner Production:

1. Details of organization and baseline data collection
2. Preparing block diagrams for individual section
   2.1 Brief description of process
   2.2 Block diagram preparation
3. Identification of waste streams
   3.1 Mass and Energy balance
4. Quantification, characterization and assigning cost to waste streams
5. Selecting the focus area and finding CP opportunities
6. Implementation of CP opportunities and estimation of expected economic, environmental and organizational gains

2.5. Cleaner production tools:

- Good house keeping
- Reduce/Reuse/Recycle
- Raw material change
- Equipment modification
- Process modification
- Technology change

CHAPTER 3 ABOUT MOTHER DAIRY

3.1. LOCATION IN INDIA:

Mother dairy is situated on the bank of Sabarmati River at Gandhinagar, which is the capital of Gujarat state in India. The plant is well connected to two strategically important and developed cities i.e. Ahmedabad and Gandhinagar by the state highway.

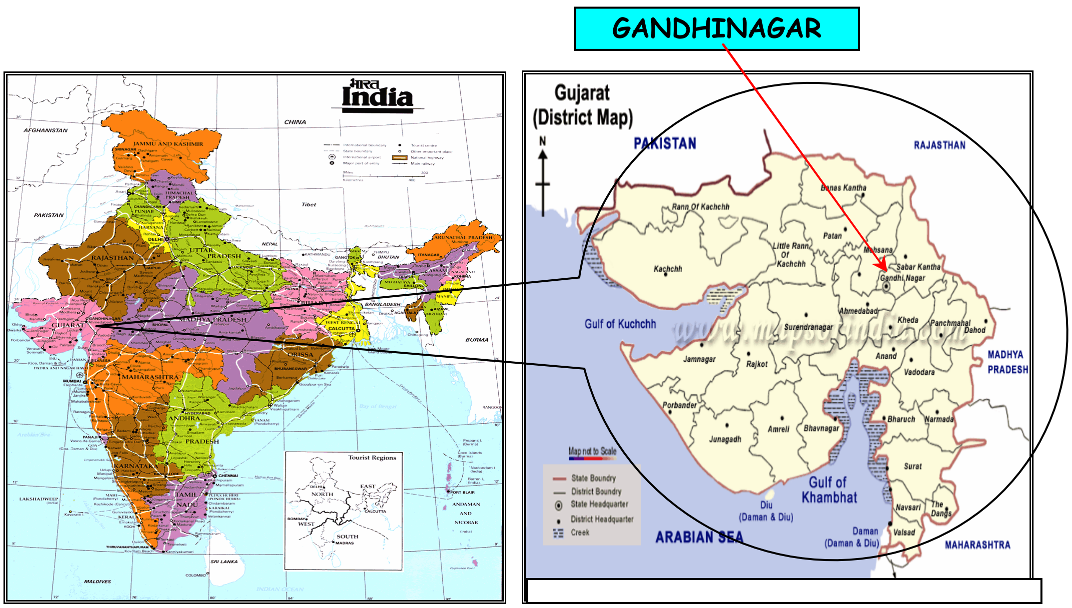

Figure: 13, Gandhinagar in India

3.1.1. Strategic importance of location

It is only 10 km from Ahmedabad railway station and 12 km from Gandhinagar Bus station which is very useful for the transportation purpose. The nearby densely populated cities ensure the local market for dairy products. Availability of labors from nearby locality at reasonable price is a distinct advantage to the company.

In addition to all this MDG enjoys more advantages from drainage facility, local community attitude, hospital, marketing complexes etc. which play an important role for establishment, development and subsequent expansion of the company.

3.2. HISTORY OF MOTHER DAIRY

Mother dairy was commissioned on Sep'19, 1994 and the initial capacity was 10 LLPD at the inception of the plant. The chronological development and expansion in the capacity is as follows:

1997

- Ice cream section installed (10 KLPD)

1998

- Ice cream from 10 to 16 KLPD
- UHT milk started (25 KLPD)
- ETP – UASB digester installed

1999

- Ice cream from 16 to 25 KLPD

2000

- UHT from 25 to 50 KLPD

2001

- Ice cream was made 80 KLPD
- Pouch capacity was increased to 8 LLPD

2002

- Mozzarella Cheese plant started (10 TPD)
- Pizza (10000 pieces per day)
- ETP – F & G trap installed

2003

- Ice cream from 80 to 100 KLPD

2004

- Ice cream from 100 KLPD to 1.8 LLPD

2005

- 100 MTD powder plant installed
- Ice cream from 1.8 to 2.5 LLPD
- ETP – 2 more UASB digester installed

3.3. MOTHER DAIRY AT A GLANCE:

Present status	Largest automated dairy in Asia & the only dairy having ISO 9002, HACCP and ISO 14001
Registered address	Mother Dairy Plot no. 35,Near Indira Bridge, Ahmedabad – Gandhinagar Highway Village Bhat, Pin - 382428 District Gandhinagar, Gujarat
Mother dairy project	Client NDDB Commencement - Jan' 1991 Processing commencement – Sep' 1994
Type of product	Full cream milk – AMUL GOLD Standardized milk – AMUL SHAKTI Toned milk – AMUL TAAZA Skimmed milk – AMUL SAATHI SMP – AMUL SAGAR WMP - AMUL Dairy whitener - AMULAYA Ghee - AMUL Ice cream - AMUL UHT milk – AMUL GOLD, AMUL TAAZA, AMUL SLIM 'N' TRIM
Marketed by	Gujarat co-operative milk marketing foundation limited
Installed capacity	10 LLPD

3.3.1. Mother dairy & its Plants:

Figure: 14, Mother Dairy

Existing plants in Mother Dairy are as following:

Table: 3, plant capacities in MDG

Plant	**Product**	**Capacity**
Butter oil	Ghee	60 TPD
Powder plant	Powder	60 MTPD
Aseptic packaging system (APS)	UHT milk	2.5 LLPD
Cheese	Cheese	10 TPD
Ice cream	Ice cream	80 KLPD
Pouch	Packaged milk	8 LLPD

3.3.2. Procurement of milk:

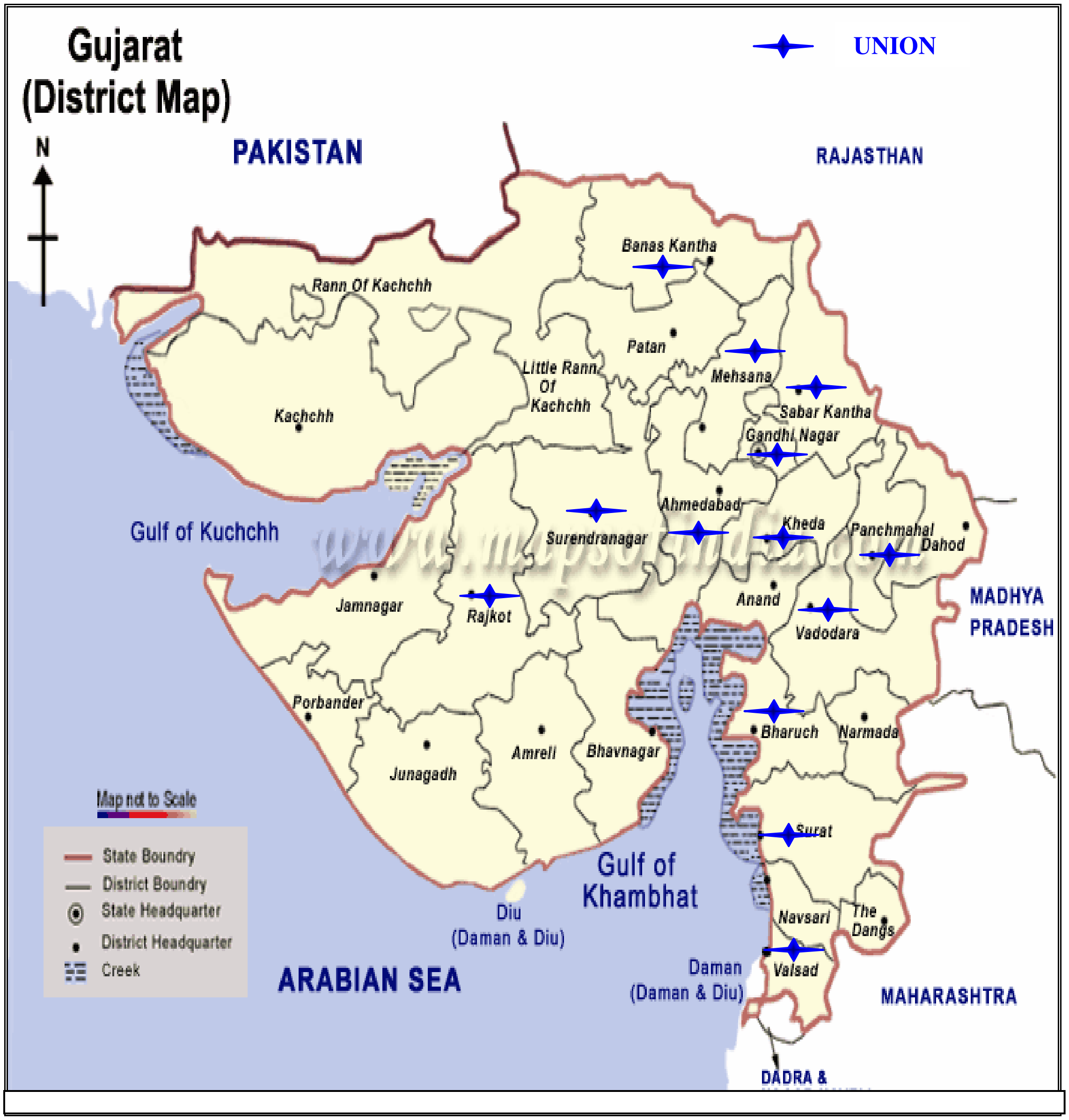

Figure: 15 Union members for milk supply for MDG

The procurement of milk by MDG is in accordance with the allotment of milk by member unions on monthly basis in GCMMF Ltd Anand. There are 13 unions shown with the notation in the map above. The milk comes in the milk tankers of standard capacity and the fat percent of milk is standardized and checked by the facility at the unions as well as at the dairy.

3.3.3. Environmental issues in MDG:

The main environmental issue is the increased waste & hydraulic load from the company which is the consequence of shear wastages of water, milk & milk products from the production sections. The reasons contributing towards these are most of the time unintentional & sometimes unavoidable also for example:

- CIP for tankers
- CIP for installations
- Regular cleaning of floors
- Outer cleaning of vat and storage tanks

Now the above mentioned losses are absolutely unavoidable as they are required to maintain the hygiene standard demanded by dairy industries. The actual scenario in the dairy is shown by the graphs below.

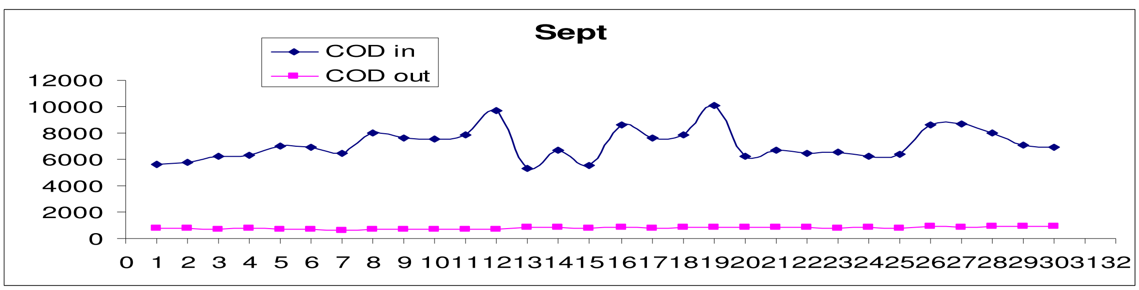

Figure: 16 COD variation in September'05

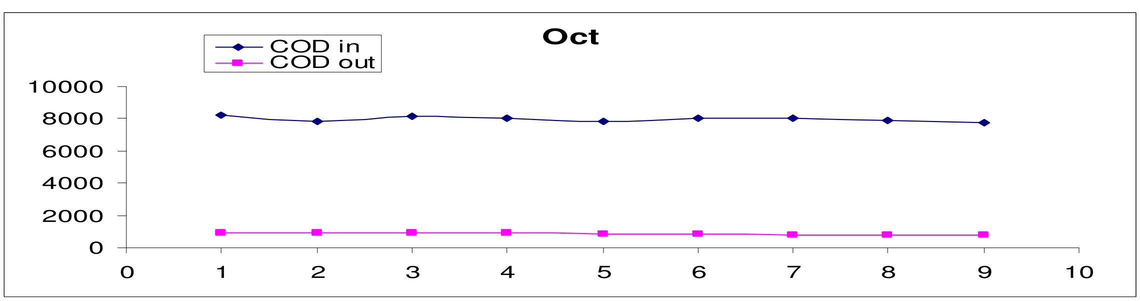

Figure: 17 COD variation in October'05

As per the pollution board norms the outlet permissible concentration for COD is 250 mg/l [6] and if the resource wastage goes on increasing it could become a problem to the dairy ETP to bring it to the required level so it becomes a matter of non compliance with the regulations. The root cause for the increased waste load lies in excess wastages of resources which need to be controlled and it has to be from the source side to make it count economically.

Now the discussed issue of waste from the dairy is giving them triple losses which are following:

1. Resource loss
2. Productivity loss
3. Environmental loss & threat for non compliance

As it is quoted above that the reduction in pollution is required from the source side so Mother Dairy is in acute need of a tool/technology which can do it for them.

CHAPTER 4 CP APPLICATIONS IN MDG

CLEANER PRODUCTION APPLICATIONS IN MOTHER DAIRY

The exercises of cleaner production begun in Mother Dairy with the collection of base line information about the dairy, its products and resource consumption.

4.1. BASELINE DATA COLLECTION

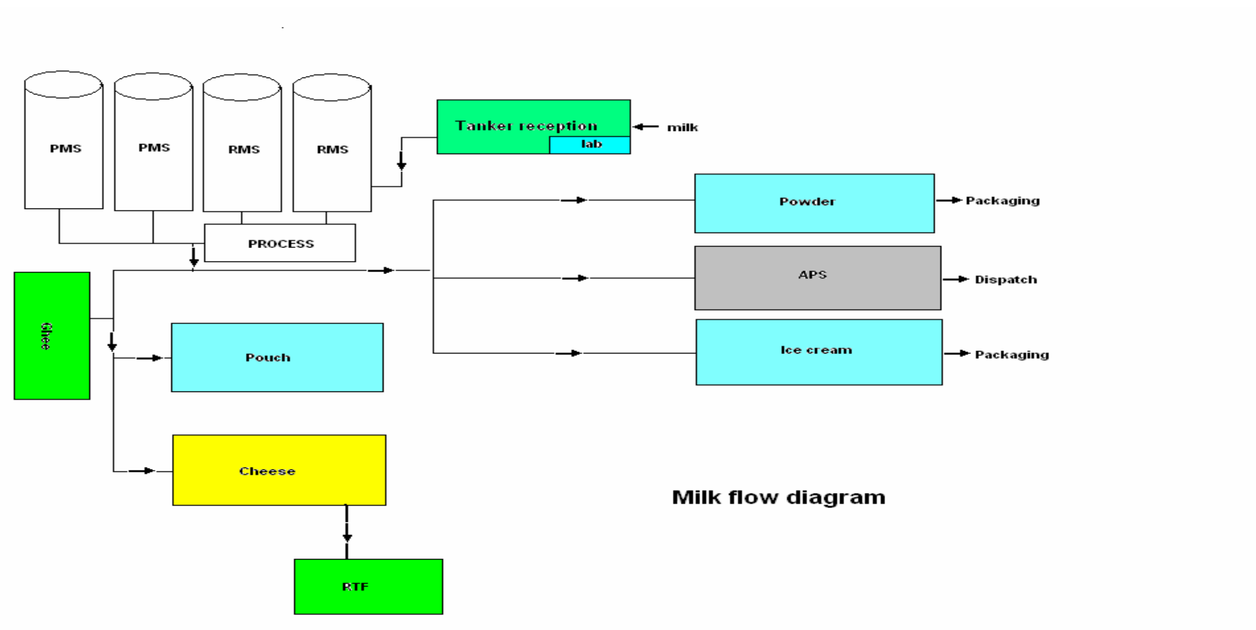

Figure: 18, Milk flow diagram for MDG

Table: 4, Data collected (MDG)

MONTH	Milk received (LLPM)	KWH	KWH/L	KWH / day	FO consumption	FO consumed/day
April	300	1488920	0.004963067	49631	303512	10117
May	267	1639280	0.006139625	52880	297889	9609
Jun	243	1563320	0.006433416	52111	283380	9446
July	166	1511820	0.009107349	48768	245810	7929
Aug	243	1396120	0.00574535	45036	279543	9018
Sep	301	1632680	0.005424186	54423	442540	14751
Oct	334	1782320	0.005336287	57494	568621	18343
Nov	329	1637880	0.004978359	54596	558551	18618
Dec	322	1534816	0.004766509	49510	606669	19570
Jan	340	1663888	0.004893788	53674	593001	19129
Feb	297	1545840	0.005204848	55209	514791	18385
March	292	1847000	0.006325342	59610	563451	18176

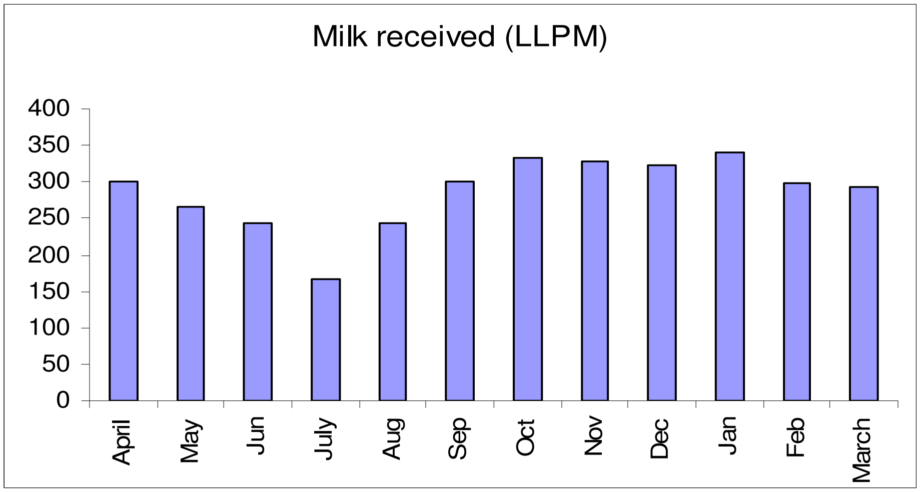

Figure: 19, Milk received per Month

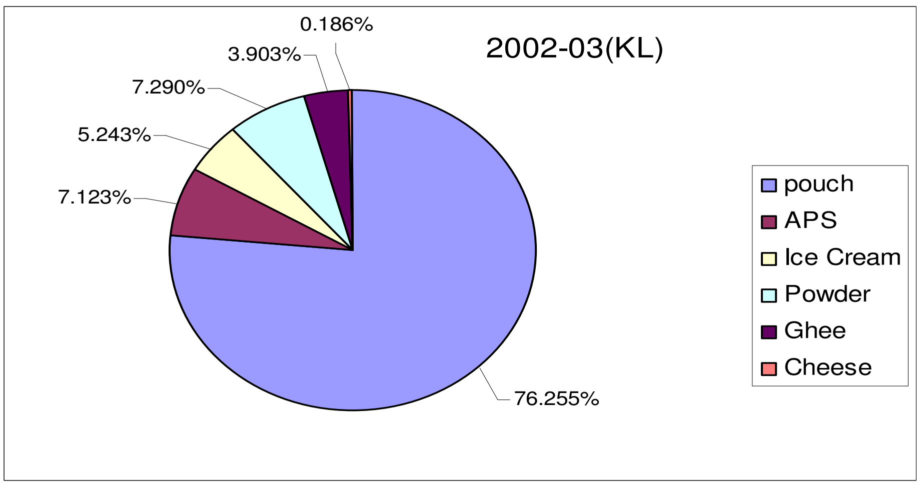

Figure: 20, Percent distribution of Milk'2002-03

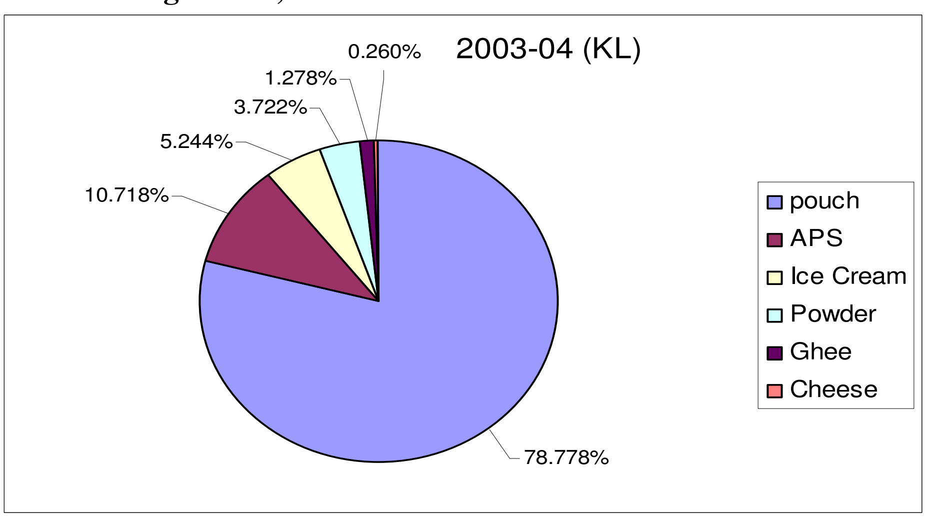

Figure: 21, Percent distribution of Milk'2003-04

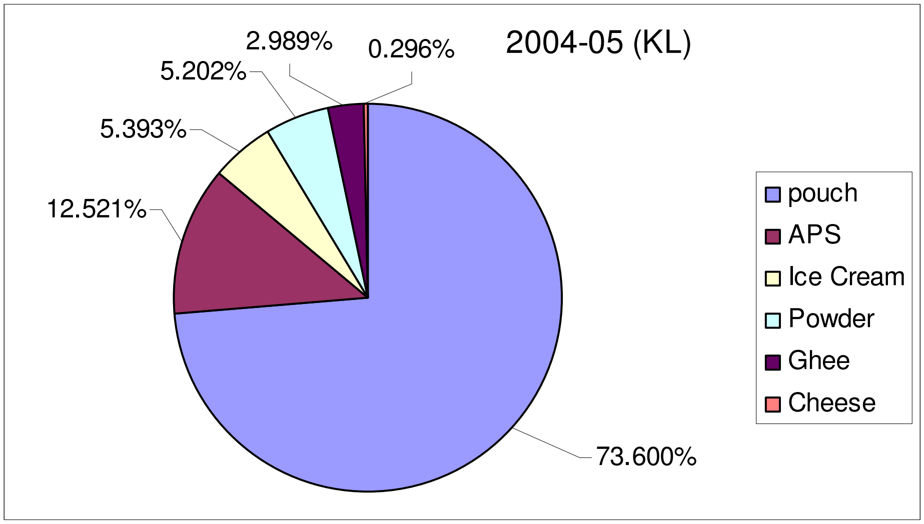

Figure: 22, Percent distribution of Milk'2004-05

About the ETP:

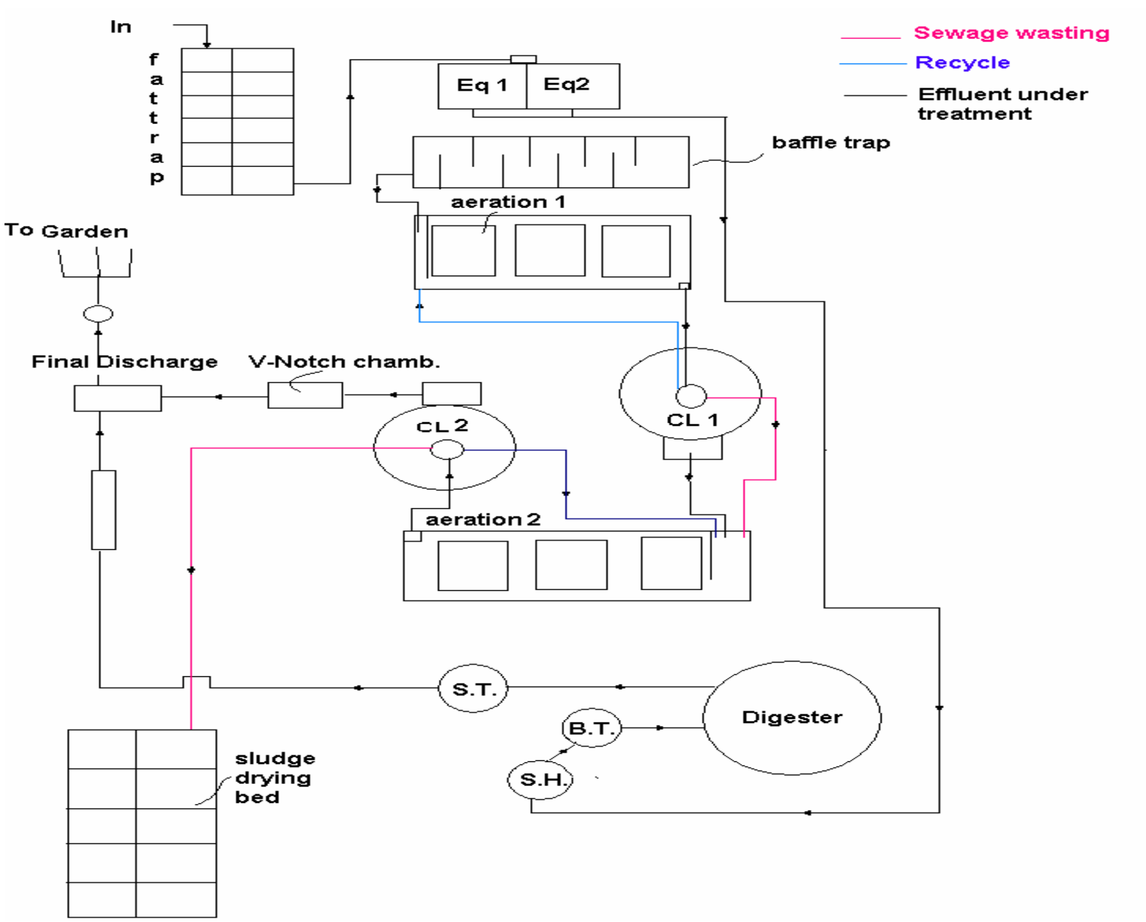

Figure: 23, Flow diagram of ETP (MDG)

Capacity and associated mechanical equipments detail of E.T.P.

Table: 5, Facility in ETP (MDG)

	Unit	**Size capacity**	**Associate mechanical equipment**
1	Oil and grease trap(50cum)	(33.2*4.2*2)m	----
2	Screen chamber	(2.5*0.15*0.45)m	----
3	Equalization tanks(2nos)	(11.5*11.5*3.3)m	2 nos 10 HP floating type surface aerator
4	Buffer tank(50 cum)	(26.5*2.3*1.1)m	----
5	Biomethanation reactor (UASB)	665 m^3	----
6	Sludge thickener	50m^3	
7	First stage aeration	(33*11*3.5)m	3 nos 25 HP surface fixed aerators
8	First stage clarifier tank	14 m dia and 2.8m depth	Mechanical scrapper and 2 nos 7.5 HP sludge recirculation pump
9	Second stage aeration tank	(36*12*4)m	3 nos 20 HP surface fixed aerators
10	Second stage clarifier	14 m dia and 2.8m depth	Mechanical scrapper and 2 nos 7.5 HP sludge recirculation pump
11	V-notch chamber	(6*1*1.3)m	-----
12	Sludge drying bed(12 nos)	(15*12*0.3)m	2 HP filtrate pump

Average Effluent received = 14 LLPD
Average COD inlet = 7500 – 8000 mg/l

Power utilized in ETP:

Table: 6, Power employed (ETP)

Pump HP utilized	Total Power	Purpose
2* 10 hp	20 hp	Equalization
3* 20 hp	60 hp	Aerators (Aeration 1)
3* 25 hp	75 hp	Aerators (Aeration 2)
2* 7.5 hp	15 hp	Scraper
2* 10 hp	20 hp	Transfer
1* 2 hp	2 hp	Filtrate
2* 7.5 hp	15 hp	Recycle
2* 10 hp	20 hp	Bio-Methanation

Total power employed = **227 hp**

All the above information was collected in order to get the idea about the actual status of the company so that the areas to be focused are clear. After all the data collection we were ready to apply the tools of Cleaner Production section by section with the objective of resource conservation and pollution prevention.

Cleaner production exercise 1

4.2. WATER CONSERVATION

The very 1st job assigned was the conservation of water in Mother dairy for which we have collected the data and then the analysis was done in order to find out the ways and means for water conservation.

Water consumption is more:

- Due to large demand for quality assurance
- Unhealthy operating practices
- Domestic consumption is enormously high (Almost 8 times than required)

Data collected:

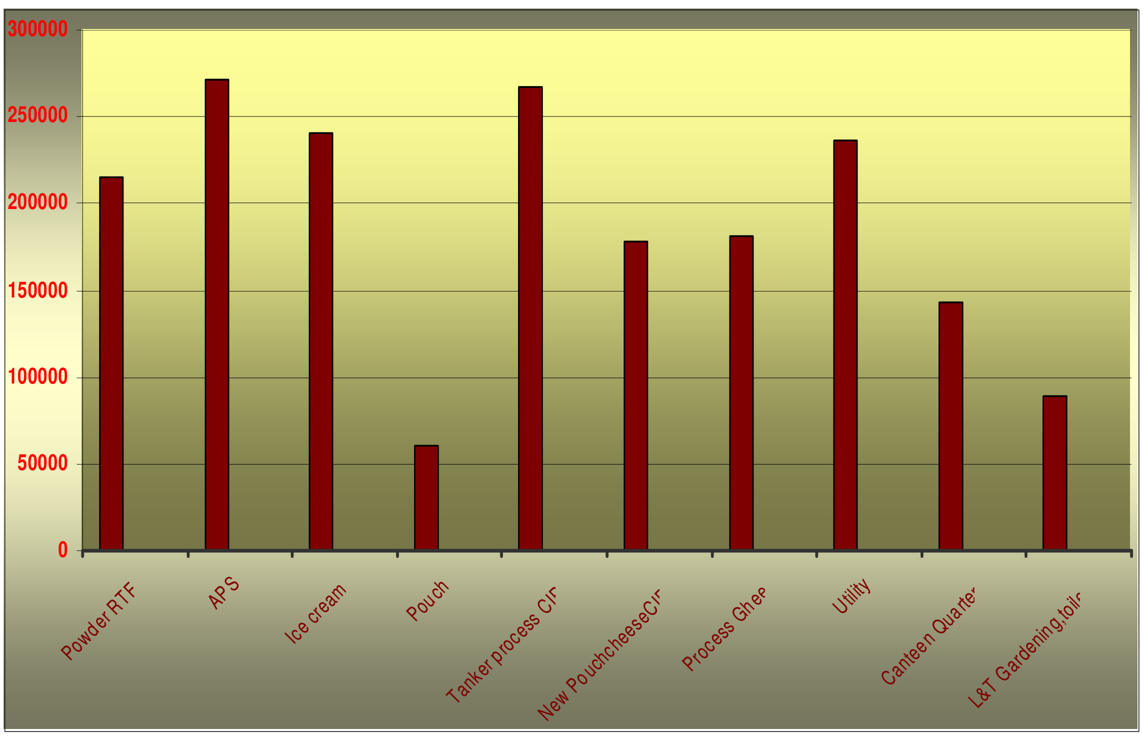

Figure: 24, Average usage of water by all sections

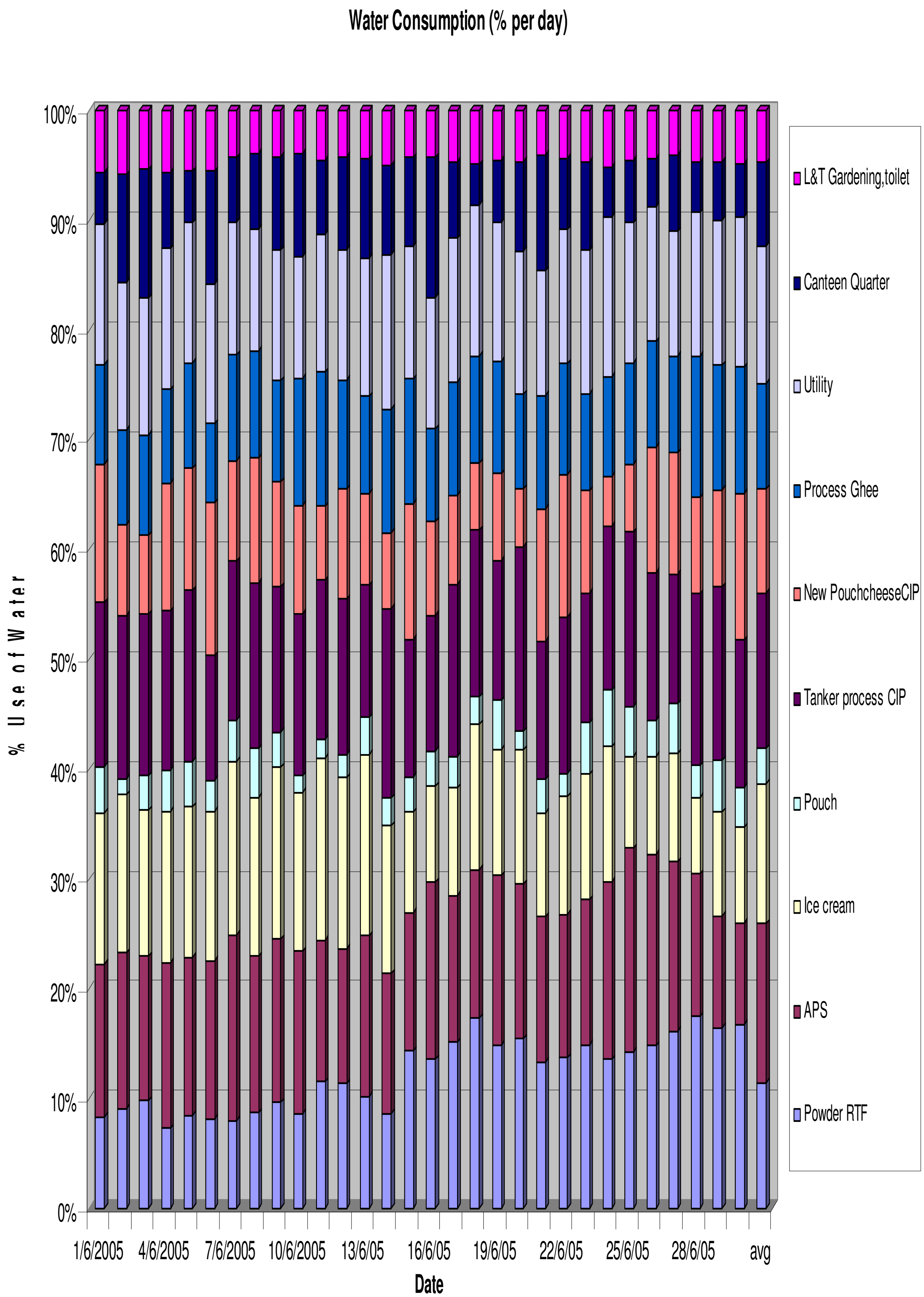

Figure: 25, Variation of water consumption

Continued:

The following graphs show the consumption pattern of water in different sections of the Dairy.

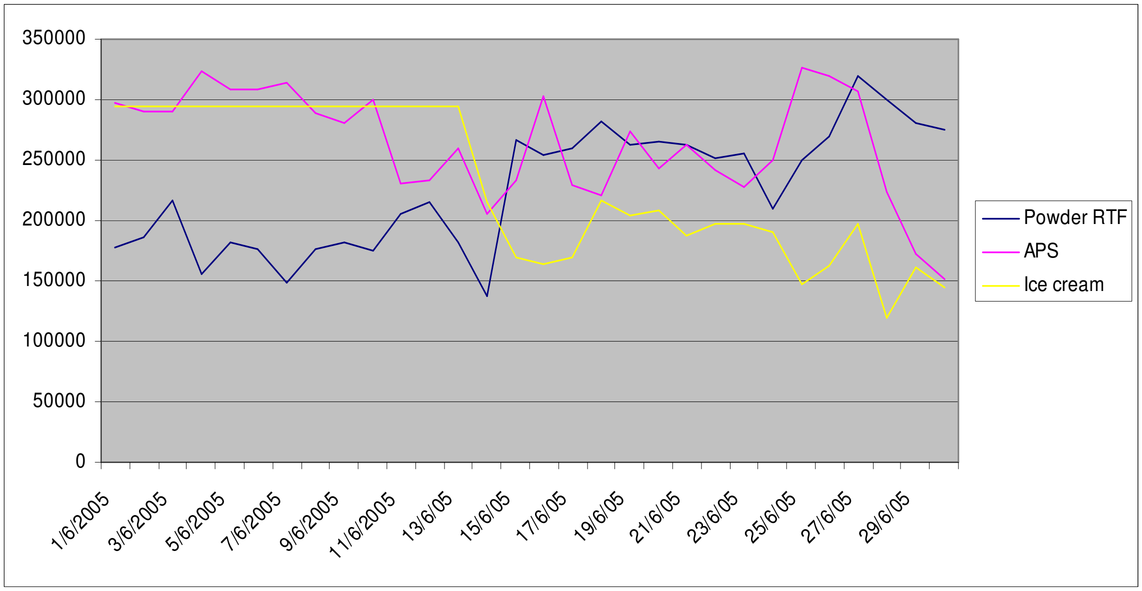

Figure: 26, Trends in water utilization

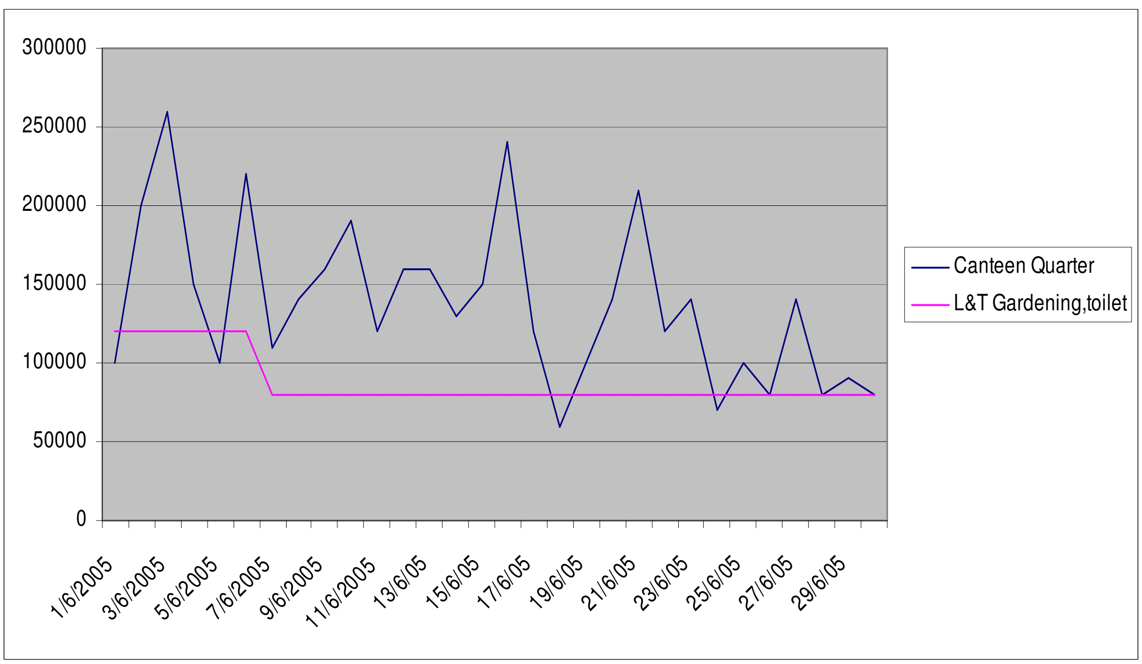

Figure: 27, Trends in water utilization

Continued:

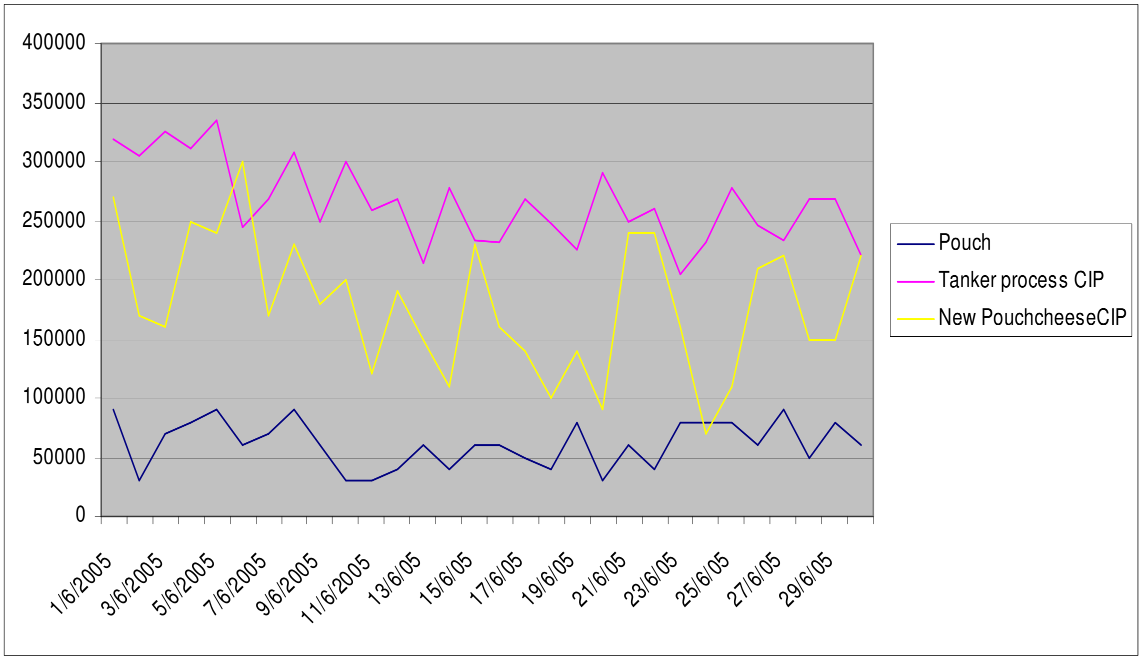

Figure: 28, Trends in water utilization

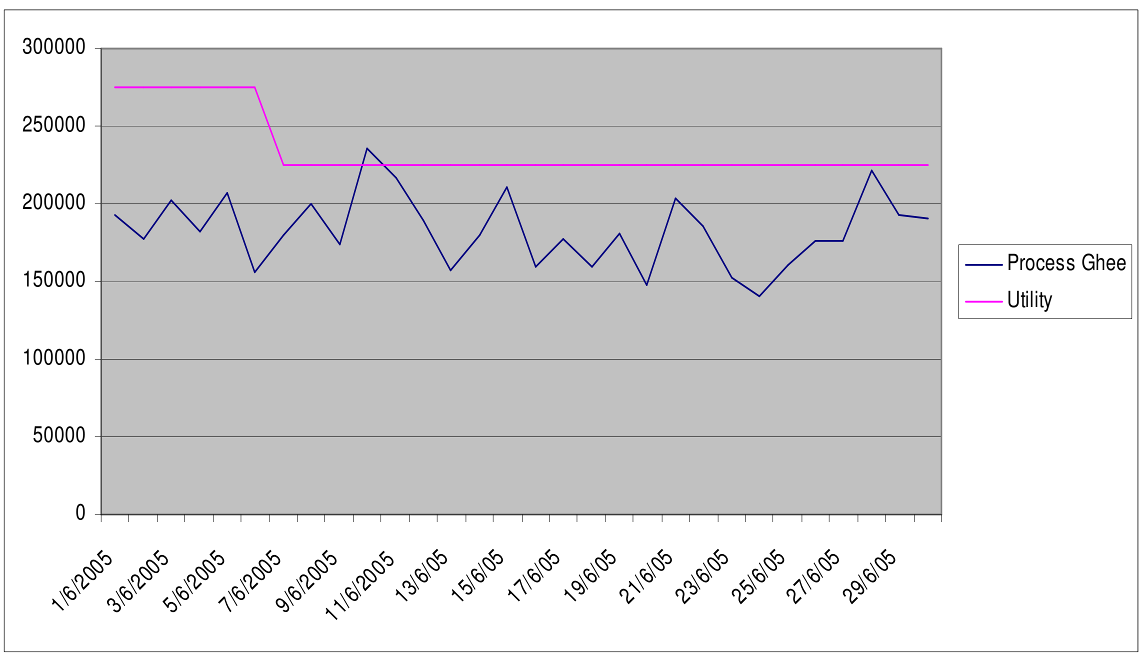

Figure: 29, Trends in water utilization

Glimpses of resource (Water) wastages:

Figure: 30, wastages of resource

Figure: 31, wastages of resource

Figure: 32, wastages of resource

After the data collected for raw water consumption we have tried to locate the possibilities of saving the water.

Conclusions from charts:

- CHART 1: Ice cream has increasing trend
- CHART 2 : RTF and Powder has increased enormously
- CHART 3: New pouch cheese CIP has great fluctuations
- CHART 4 : Process Ghee has fluctuations

Variations were attributed to

- Human mistakes
- Operating practices
- Production time
- Leakages/ Ruptures
- Meter malfunctioning

Lacking areas

- Operating practices" cleaning”
- Incompetence or ignorance of employees
- Operational limitations “plate count on the suggestion”
- User ignorance
- Lack of data (no meters at the outpoints + there are places where water meters are required)
- Lack of research work
- No driving force (incentive or appreciation letter)

Areas to be focused:

- CIP
- Plants where CIP is not available (Manual)
- Residential blocks, Hostel & Canteen
- Area under construction and labor colony

CP opportunities:

1. Use of non-recoverable detergents
2. Reduce / reuse / recycle
3. Installation of a common skimmer to recover fat content and recoverable (IF) water from each and every first wash of storages and installation
4. Cleaning practices improvement
5. Control in the reception of raw materials
6. Improvement in operating practices

Use of non recoverable detergents:

Complete CIP cleaning in a dairy industry is usually composed of the following stages:

- Initial rinsing
- Detergent phase with a caustic agent to remove organic residues
- Intermediate rinsing
- Scrubbing phase with an acidic agent for elimination of calcareous deposits
- Intermediate rinsing
- Disinfection of installations
- Final rinsing

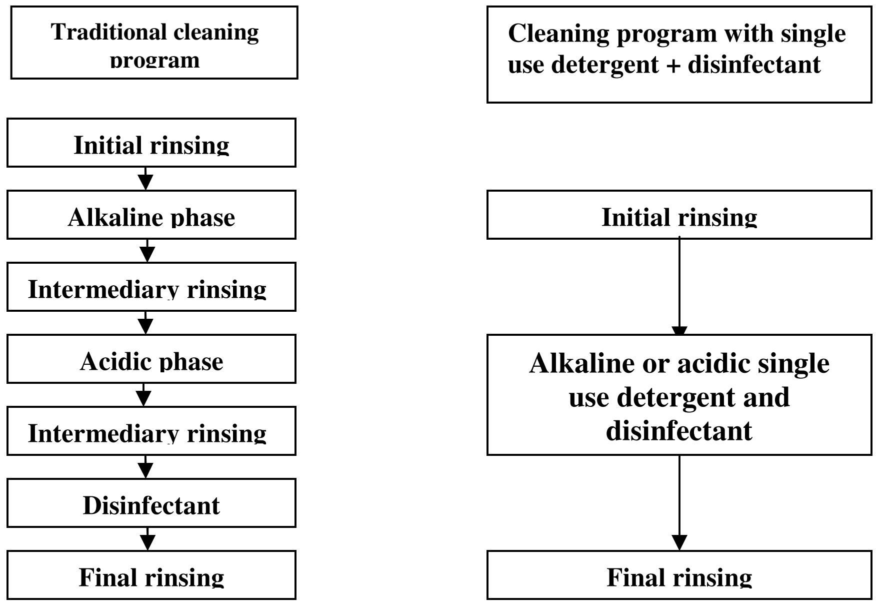

Figure: 33, Comparison of various CIP techniques

The advantages are:

- Decrease in cleaning time "means increase in production hours"
- Decrease in Phosphorus and nitrogen content "means less load on the ETP"
- Decrease in energy consumption" means less electrical bills and environmental advantages "
- Decrease in water consumption

Reduce and recycle: Already implemented

- Washing section (blower modification + Recycling via. pump)

Areas to offer opportunities

- CIP (Last rinse of last as first rinse to next)
- RTF (All manual operation)
- All cleaning operation (Replacement of water with air guns/Brooms/Mopping)
- Residential blocks……
- Tanker (Last wash of latter as 1^{st} wash of next tanker)

Last wash of latter as 1st wash of next tanker

Saving per wash= 125 liter (Approximately)

Total tanker washed/day=70-80

So total saving =8750-10000 liters/day

Cleaning practices

Total water saving (On changing practices)

Example: cheese section

Flow rate = ½ liter/sec

Average cleaning time = 1hr

Water consumed **=1800 lit/hr**

Results:

1. Application of non recoverable detergent was not economically viable (Demo by HLL)
2. They now have decided to recycle their 1st flushes from every tanker wash
3. Management is thinking about employing a technology to recover valuable fat as well as to purify water and reuse it.

Future work

- Feasibility analysis (Technical & economical) for all suggested options
- Water efficiency program for residential and refreshment facility (Written procedures)
- Training and awareness program for employees contract labor and residents (for efficient use)
- Sample analysis for every section outpoint to identify the maximum load to ETP

Cleaner production exercise 2

4.3. PROCESS SECTION (MDG)

Receipt and storage of milk

Depending on the structure and traditions of the primary production sector, milk may be collected directly from the farms or from central collection facilities. Farmers producing only small amounts of milk normally deliver their milk to central collection facilities. At the central collection facilities, operators measure the quantity of milk and the fat content. The milk is then filtered and/or clarified using centrifuges to remove dirt particles as well as udder and blood cells.

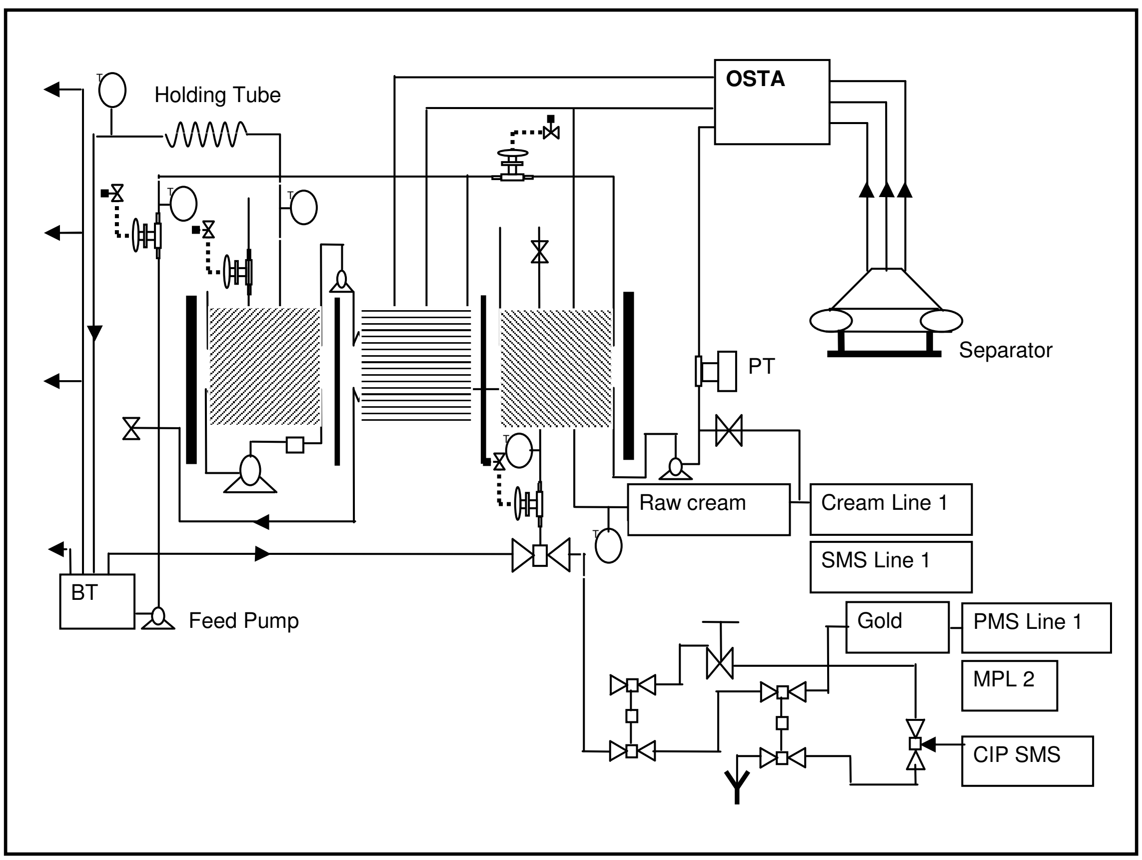

Figure: 34, Process flow diagram for pasteurization

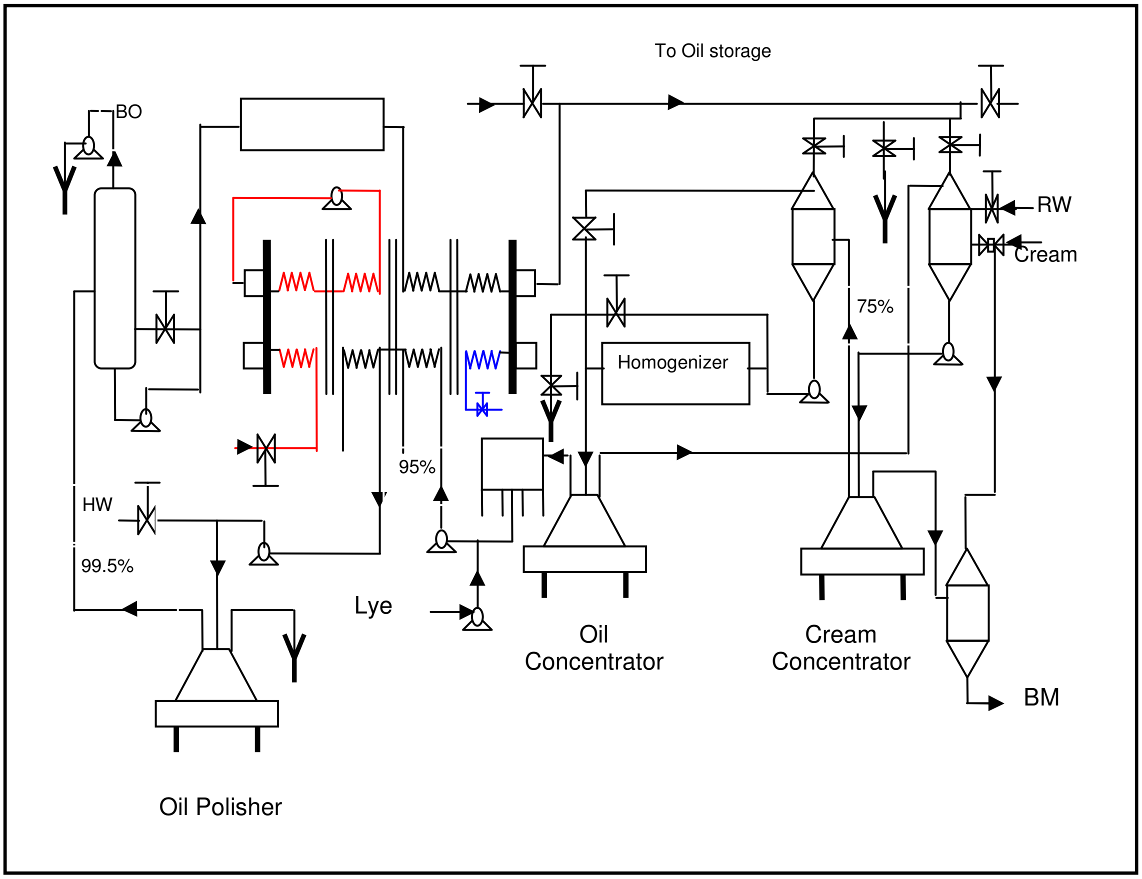

Figure: 35, Process flow diagram for Butter oil (Ghee) preparation

The milk is then cooled using a plate cooler and pumped to insulated or chilled storage vessels, where it is stored until required for production. Empty tankers are cleaned in a wash bay ready for the next trip. They are first rinsed internally with cold water and then cleaned with the aid of detergents or a caustic solution. To avoid build-up of milk scale, it is then necessary to rinse the inside of the tank with a nitric acid wash. Tankers may also be washed on the outside with a cold water spray. Until required for processing, milk is stored in bulk milk vats or in insulated vessels or vessels fitted with water jacket.

Block diagram for process section:

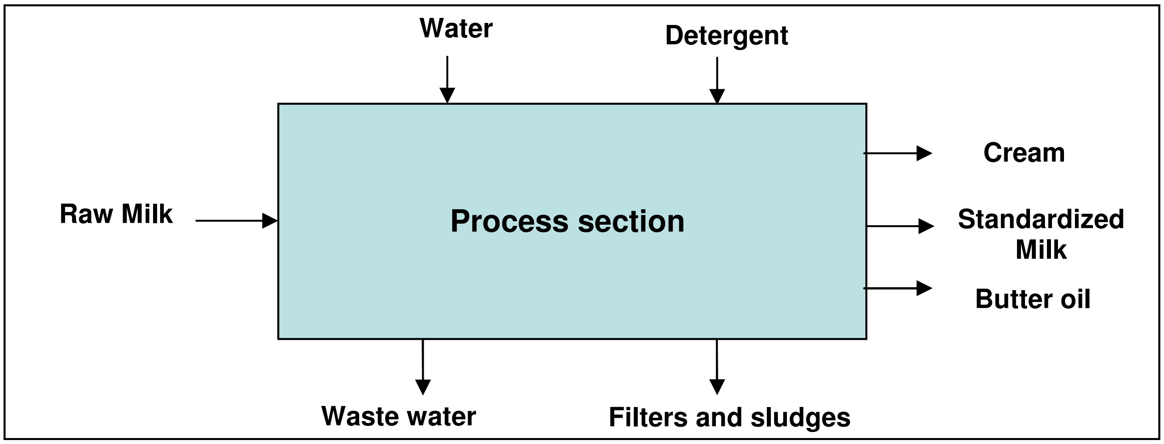

Figure: 36 (Inputs and outputs from milk receipt and storage)

Water is consumed for rinsing the tanker and cleaning and sanitizing the transfer lines and storage vessels. The resulting effluent from rinsing and cleaning can contain milk spilt when tanker hoses are disconnected. This would contribute to the organic load of the effluent stream.

Solid waste is generated from milk clarification and consists mostly of dirt, cells from the cows' udders, blood corpuscles and bacteria. If this is discharged into the effluent stream, high organic loads and associated downstream problems can result.

Table given provides indicative figures for the pollution loads generated from the washing of tankers.

Table: 7, Specific data for different sections [4]

Main product	Wastewater (m^3/tonne milk)	COD (kg/tonne milk)	Fat (kg/tonne milk)
Butter plant	0.07–0.10	0.1–0.3	0.01–0.02
Market milk plant	0.03–0.09	0.1–0.4	0.01–0.04
Cheese plant	0.16–0.23	0.4–0.7	0.006–0.03
Havarti cheese plant	0.60–1.00	1.4–2.1	0.2–0.3

Table: 8, Specific data for different sections [4]

Main product	Wastewater (m^3/tonne milk)	COD (kg/tonne milk)	Fat (kg/tonne milk)
Market milk plant	0.08–0.14	0.2–0.3	0.04–0.08
Havarti cheese plant	0.09–0.14	0.15–0.40	0.08–0.24

CP Block diagram for pasteurization process:

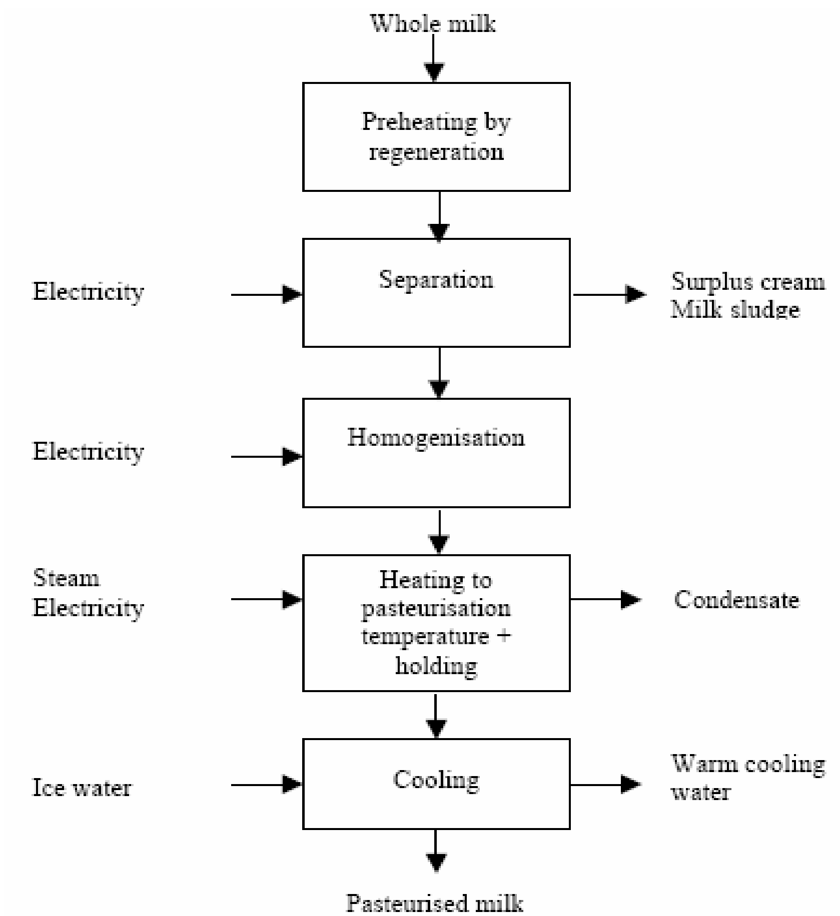

Figure: 37(Inputs and outputs from pasteurization process)

Environmental issues

The main environmental issues of the milk treatment described above are related to the high levels of energy consumed in heating and cooling of the milk, and the electricity consumed by the homogenizer, the separator and the pumps.

Water is consumed for rinsing and cleaning of the equipment, which procedure in turn results in waste water containing milk solids and cleaning agents. Water/milk mixtures are also generated at the start-up of the production line, when the water in the pipes is replaced by milk.

Cleaner Production opportunities:

In this area, focus on reducing the amount of milk that is lost to the effluent stream and reducing the amount of water used for cleaning. Ways of achieving this include:

- Avoiding milk spillage when disconnecting pipes and hoses;
- Ensuring that vessels and hoses are drained before disconnection;
- Providing appropriate facilities to collect spills;
- Identifying and marking all pipelines to avoid wrong connections that would result in unwanted mixing of products;
- Installing pipes with a slight gradient to make them self-draining;
- Equipping tanks with level controls to prevent overflow;
- Making certain that solid discharges from the centrifugal separator are collected for proper disposal and not discharged to the sewer;
- Improving cleaning regimes and training staff;
- Installing trigger nozzles on hoses for cleaning;
- Reusing final rinse waters for the initial rinses in CIP operations;
- Collecting wastewater from initial rinses and returning them to the dairy farm for watering cattle.

Sampling exercise at process section to identify and quantify waste streams:

The entire sequence of dairy operation starts with the reception of Milk and this was the 1st place where the sources of wastages was to be found out as a perquisite of Waste Audit and a CP exercise of sampling and quantification of the waste was carried out in order to find out the potential of waste or the pollution load of Process section.

After the primary study the sources of waste were:

1. Tanker CIP
2. Product purging
3. De-sludging

The exercise began at 1st Oct '2005 and was continued for three days to get the representative sample. All the samples were taken before the cleaning of tankers in order to find out the remaining milk fat in the tanker after the unloading.

Table: 9, Sampling results

Sample No.	Tanker no.	Union	Weight (kg)	Fat (%)	CIP time & date	Dispatch time & date	Holding time (hrs)
1	6554	Banas	0.891	37	10:30/ 1st Oct	30th Sep,23:50	10
2	6037	Surendranagar	2.968	37	11:15/ 1st Oct	1st Oct,02:45	8
3	5076	Valsad	10.929	74	13:35/ 1st Oct	29th Sep,03:00	58
4	3987	Mehsana	1.5	16	14:25/ 1st Oct	1st Oct,00:14	14
5	9441	Banas	4.05	37	18:15/1st Oct	30th Sep,23:57	18
6	2212	Sabar	1.54	41	19:45/1st Oct	1st Oct,08:45	11
7	5397	Surendranagar	2.93	70	21:40/1st Oct	1st Oct,07:45	14
8	9699	Bhavnagar	2.1	72	22:15/ 1st Oct	1st Oct,09:15	13
9	6027	Banas	5.1	45	10:40/2nd Oct	1st Oct,11:30	23
10	4807	Banas	5.3	52	10:55/ 2nd Oct	1st Oct,13:30	22
11	6807	Banas	4.2	46	11:42/ 2nd Oct	1st Oct,11:00	24
12	6399	Valsad	5.3	45	13:00/ 2nd Oct	1st Oct,04:45	32
13	6224	Banas	6.15	53	13:15/ 2nd Oct	1st Oct,14:30	23
14	2682	Banas	3.5	52	13:40/ 2nd Oct	1st Oct,16:30	21
15	4767	Banas	2.5	36	14:15/ 2nd Oct	1st Oct,17:15	21
16	9205	Banas	1.8	59	15:40/ 2nd Oct	1st Oct,22:38	17
17	7116	Mehsana	1.3	42	15:55/ 2nd Oct	2nd Oct,08:16	7
18	3987	Mehsana	1.1	32	16:50/ 2nd Oct	2nd Oct,00:41	16
19	4302	Banas	2.1	36	16:20/ 2nd Oct	2nd Oct,00:12	16
20	5635	Vihar	1.2	38	17:25/ 2nd Oct	2nd Oct,00:27	17
21	3733	Gandhinagar	0.9	36	18:00/ 2nd Oct	2nd Oct,12:10	6
22	5827	Mehsana	1.2	32	18:18/ 2nd Oct	2nd Oct,10:12	8
23	839	Sabar	1.1	60	18:40/ 2nd Oct	2nd Oct,10:30	6
24	146	Gandhinagar	1.2	45	19:55/ 2nd Oct	2nd Oct, 12:40	7
25	5397	Surendranagar	1.4	31	20:55/ 2nd Oct	2nd Oct,09:00	11
26	4509	Mehsana	1.8	35	21:40/ 2nd Oct	2nd Oct,14:00	7
27	5807	Surendranagar	3.1	45	22:20/ 2nd Oct	2nd Oct,10:00	12
28	6527	Sabar	1.5	41	23:10/ 2nd Oct	2nd Oct,10:10	12
29	6898	Banas	2.8	51	00:05/ 3rd Oct	1st Oct,23:55	24
30	6424	Sabar	2.1	38	00:26/ 3rd Oct	2nd Oct,11:45	12
31	9701	Surendranagar	4.8	65	01:05/ 3rd Oct	2nd Oct,11:00	14
32	6198	Sabar	3.5	47	01:30/ 3rd Oct	2nd Oct,18:00	7
33	6523	Mehsana	0.9	30	02:05/ 3rd Oct	2nd Oct,21:02	5
34	2334	Kaira	0	0	02:30/ 3rd Oct	2nd Oct,21:10	5
35	5027	Mehsana	0	0	02:35/ 3rd Oct	2nd Oct,10:16	16
36	6807	Sabar	1.1	52	03:10/ 3rd Oct	2nd Oct,20:15	7
37	6801	Mehsana	0	0	03:21/ 3rd Oct	2nd Oct,10:35	17
38	5635	Mehsana	0.9	33	03:55/ 3rd Oct	3rd Oct,00:30	3
39	3987	Mehsana	1.1	21	04:10/ 3rd Oct	3rd Oct,00:57	3
40	5945	Amul sagar	2.6	19	04:45/ 3rd Oct	2nd Oct,21:57	8

41	1295	Rajkot	5.4	28	05:00/ 3rd Oct	2nd Oct,10:00	19
42	6477	Mehsana	0.9	20	05:05/ 3rd Oct	2nd Oct,21:38	7
43	9617	Mehsana	0	0	05:12/ 3rd Oct	2nd Oct,22:15	7
44	5812	Kaira	0	0	08:15/ 4th Oct	4th Oct,03:00	5
45	2654	Banas	7.5	52	09:15/ 4th Oct	2nd Oct,15:20	40
46	2770	Banas	2.8	58	09:20/ 4th Oct	2nd Oct,13:30	44
47	7700	Valsad	5.9	26	10:05/ 4th Oct	2nd Oct,21:00	37
48	5727	Banas	9.1	46	12:25/ 4th Oct	2nd Oct,19:15	41
49	5807	Surendranagar	3.4	49	12:55/ 4th Oct	4th Oct ,00:30	12
50	6375	Surendranagar	2.9	40	13:10/ 4th Oct	4th Oct ,1:45	11
51	6477	Mehsana	0	0	13:40/ 4th Oct	4th Oct,09:21	4
52	6260	Banas	3.1	50	14:10/ 4th Oct	3rd Oct,01:09	27
53	7116	Mehsana	0	0	14:35/ 4th Oct	4th Oct ,8:31	6
54	6027	Banas	2.1	58	15:20/ 4th Oct	2nd Oct, 21:26	42
55	6523	Mehsana	0	0	15:35/ 4th Oct	4th Oct ,10:11	4
56	5635	Mehsana	0.9	38	16:10/ 4th Oct	4th Oct ,12:29	4
57	839	Sabar	1.2	29	16:20/ 4th Oct	4th Oct 09:40	7
58	4914	Rajkot	5.6	37	16:50/ 4th Oct	3rd Oct ,12:20	28
59	6224	Sabar	1.6	30	17:30/ 4th Oct	2nd Oct,23:36	41
60	4509	Mehsana	0	0	17:54/ 4th Oct	4th Oct ,09:43	8
61	6527	Sabar	1.8	32	18:02/ 4th Oct	4th Oct 06:30	12
62	5717	Banas	0	0	18:16/ 4th Oct	2nd Oct,23:40	42
63	6195	Sabar	0	0	18:30/ 4th Oct	4th Oct 09:50	9
64	6037	Banas	2.2	39	18:40/ 4th Oct	2nd Oct,21:53	44
65	2212	Sabar	1.1	42	19:10/ 4th Oct	4th Oct ,09:45	10
66	9617	Mehsana	0.9	48	19:23/ 4th Oct	3rd Oct ,23:26	20
67	5027	Mehsana	0	0	20:10/ 4th Oct	4th Oct ,10:56	9
68	3733	Gandhinagar	3.1	42	20:40/ 4th Oct	3rd Oct ,12:40	30
69	5349	Sabar	0	0	20:59/ 4th Oct	4th Oct ,09:55	10
70	9394	Valsad	5.7	58	21:20/ 4th Oct	2nd Oct ,10:25	59
71	6477	Mehsana	0	0	01:10/ 5th Oct	4th Oct ,09:21	16
72	6801	Mehsana	1.3	20	01:24/ 5th Oct	4th Oct, 20:38	5
73	9701	Surendranagar	2.3	24	02:02/ 5th Oct	4th Oct,17:40	9
74	5827	Mehsana	0	0	02:15/ 5th Oct	4th Oct,21:34	5
75	6523	Mehsana	0	0	02:40/ 5th Oct	4th Oct,21:54	5
76	4509	Mehsana	0	0	03:05/ 5th Oct	4th Oct,22:00	5
77	5635	Mehsana	0	0	03:45/ 5th Oct	5th Oct,00:07	4
78	636	Rajkot	4.2	15	03:50/ 5th Oct	4th Oct,13:45	14
79	6735	Panchmahal	1.1	25	04:00/ 5th Oct	4th Oct,02:00	22
80	3987	Mehsana	0	0	04:10/ 5th Oct	5th Oct,00:16	4
81	7902	Banswada	2.1	32	04:50/ 5th Oct	4th Oct,13:45	15
82	5027	Mehsana	0	0	05:00/ 5th Oct	5th Oct,01:40	4
83	5381	Rajkot	0.9	16	05:10/ 5th Oct	4th Oct, 13:15	16

Duration of exercise:

1st October'05	10:00 am - 11:00pm
2nd October'05	10:40 am – 05:15 am (3rd October)
4th October'05	07:15 am – 06:00 am (5th October)

Results:

1. **Fat recovered**

   Total fat recovered = **177.558 kg**

   Max. Fat/Tanker = 10.9 kg

   Min. Fat/Tanker = 0 kg

   Avg. fat/tanker = **2.13 kg**

2. **Percentage of fat**

   Max. = 74%

   Min. = 16%

   Avg. = 44%

Discussion:

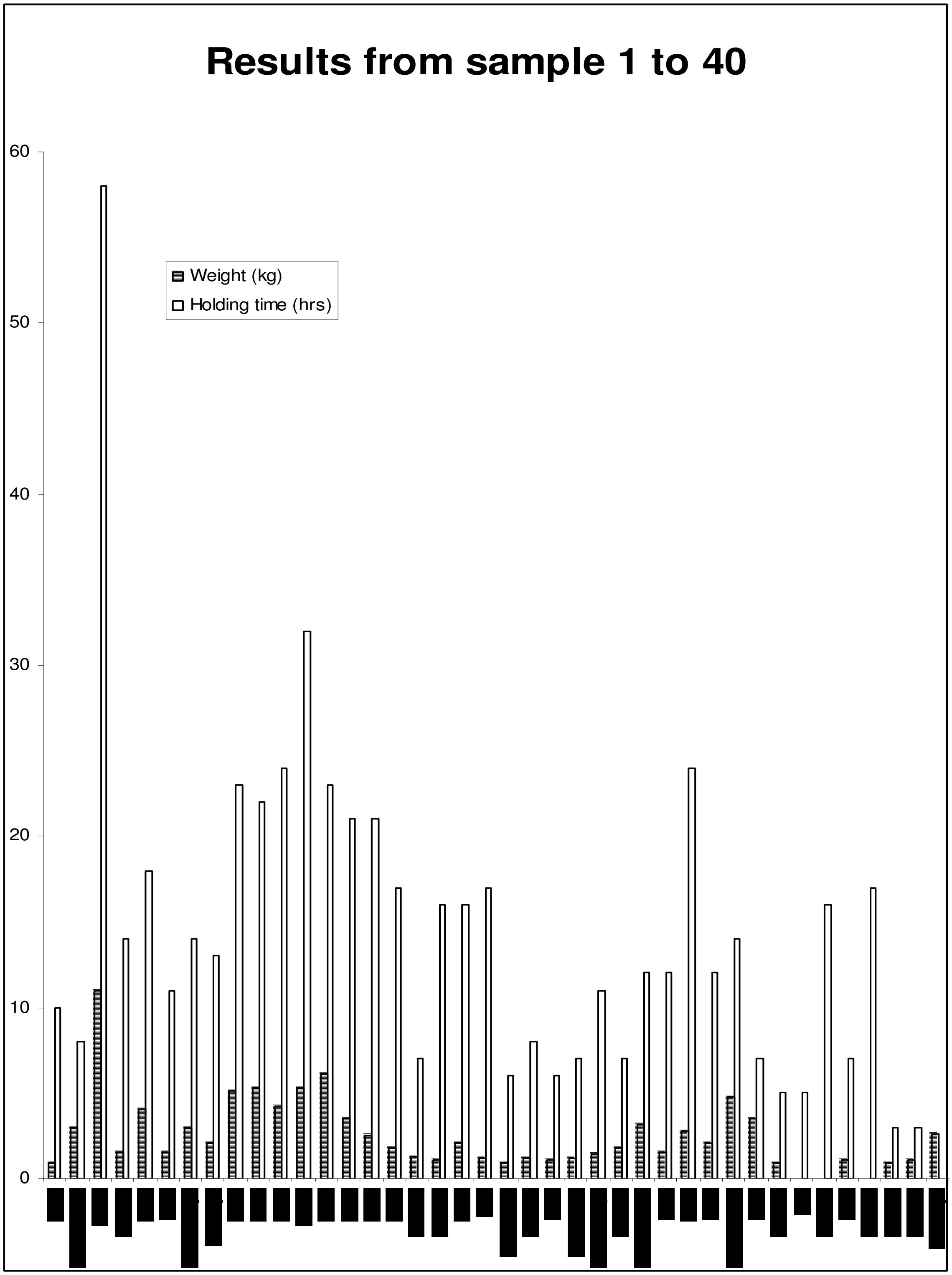

Figure: 41, Results from sample 1 to 40

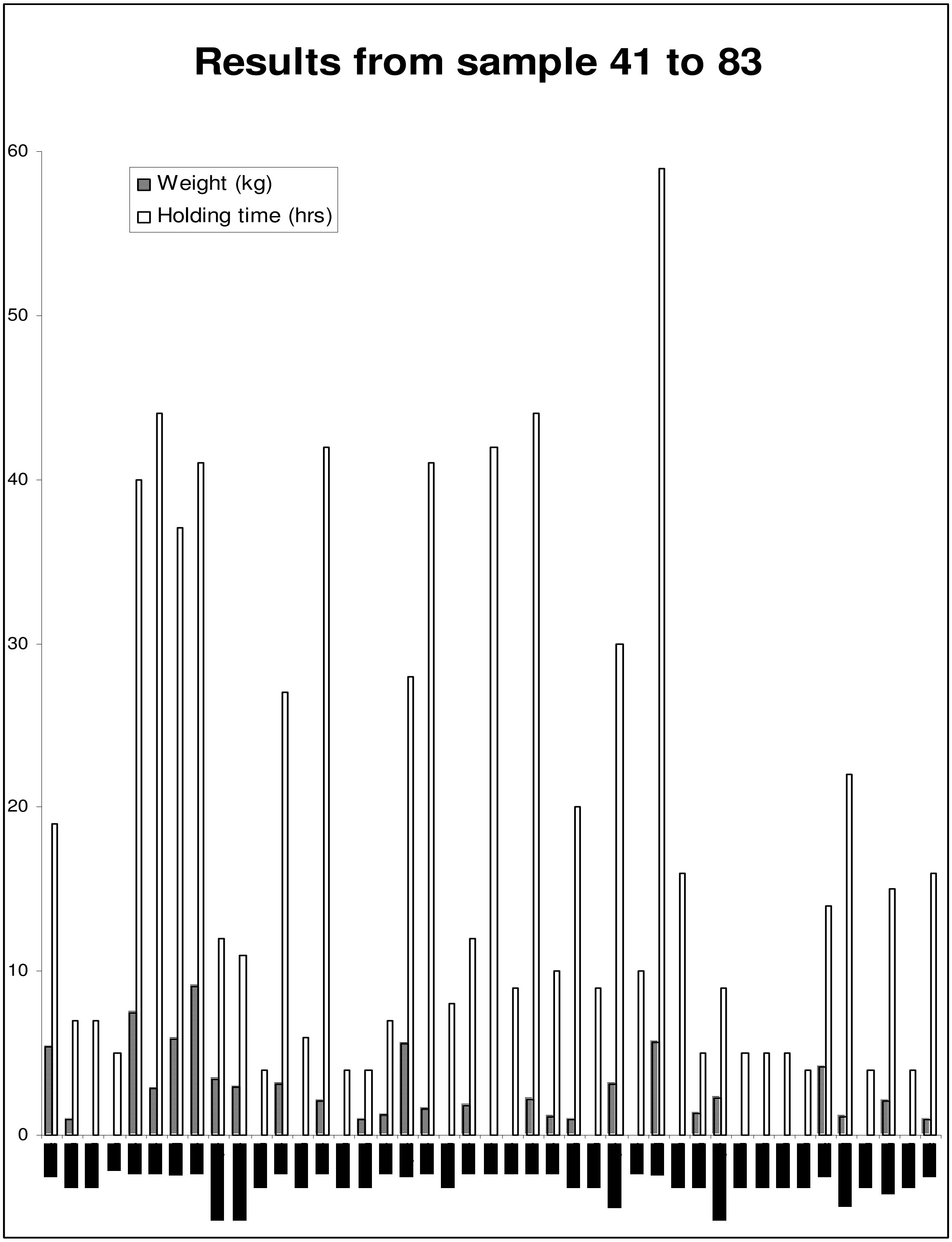

Figure: 42 Result from sample 41 to 83

It was very clear that as the holding time of Milk in the tanker is increasing, the fat recovered before CIP is also increasing.

Continued…

Maximum tankers received/day = 100

So fat recovered from tankers = no. of tankers x average fat/tanker

= 100 x 2.13

= **213 kg**

Now pollution load…

As per the ETP

1 mg fat = 3.09 mg COD

Now total fat = 213 x 0.44 kg

= 93.72 kg

So total COD delivered = 93.72 x 3.09

= **289.5948 kg COD**

Economic loss

Cost of 1 kg (40% fat) = 80 Rs.

Cost of 213 kg (44% fat) = 80 x 213 Rs.

= **17040 Rs/day**.

So monitory loss/year = 17050 x 365

= **62,19,600 Rs./year**

Conclusion:

The loss of milk fat causes the company dual losses:

1 Loss of milk

2 Increased Loads on ETP (**289.5948 kg COD/day**)

Previous sampling exercise has given results and the next quantification was of the 1st CIP flush of all the equipment and storages in the company to find the potential for:

1 Water conservation
2 Milk solid recovery

First of all it was decided that the samples would be taken for all installation CIP and for that Prof. Vipul Shah has even visited the company to bring home the management on this issue.

The basic problem was the arrangement of sampling facility because it was very difficult to take each CIP flush to a tank and sample as almost 60 CIP takes place in a day in company's routine. So it was discussed and was agreed that we would take samples only for some specific installations i.e.

- Raw milk silos (RMS)
- Pasteurized milk silos (PMS)
- Cream tanks
- Milk processing lines (MPL)

Composite sampling:

Table: 10, Composite sampling of installations

Sample no.	Facility	Time of flush	Flow rate (Lit/Hr)	Fat (%)
1	RMS-4	5 min	18000	5.6
2	Cream pasteurizer– 2	8 min	10500	5.4
3	Raw cream tank-2	5 min	7500	5.1
4	RMS-1	5 min	18000	7.3
5	PMS-4	6 min	17000	6.8

6	PMS-3	5 min	18000	1.9
7	PMS-3	5 min	18000	3.7
8	Balance tank-1	5 min	8600	Nothing
9	Balance tank-3	5 min	15000	Nothing
10	Cream pasteurizer– 1	5 min	12500	10.5
11	MPL-1	5 min	27000	0.2
12	Raw cream tank – 1	5 min	7600	5.1

Later on, the arrangement was made for the composite sample of whole day CIP volume and the process people arranged it to get it in the, "**Un-pasteurized milk recovery tank**" Everyday the sample was taken and checked for fat and SNF in the solution.

Averaged results:

1 Fat = 0.05 %

2 SNF = 1%

3 PH = 4.5 to 5.0

All the reports have been submitted to the management for further action and as a result they are thinking about installing a system to recycle all of their milk solids.

Results:

After the sampling exercise (Tanker), the results were given to the management and it is been principally agreed that this could be utilized so in view of resource conservation and environmental improvement they are taking their flushes back and **it would be used for the standardization of milk.**

Cleaner production exercise 3

4.4. CHEESE SECTION

Data collected:

Capacity 10 MTD

Designed by IDMC

Types of cheeses:

1. Acidified Mozzarella cheese
2. Cultured Mozzarella cheese
3. Shredded Mozzarella cheese

Statistics:

Table: 11, Statistics of Cheese plant

Financial year	**Total production**	**Total dispatch**	**Capacity utilization**
2002-2003	466.19 MT	425.23 MT	12.95%
2003-2004	595.35 MT	573.35 MT	16.54%

Process description:

Entire process is divided into two steps

1 Cutting and cooking

2 Stretching & molding

Plant description:

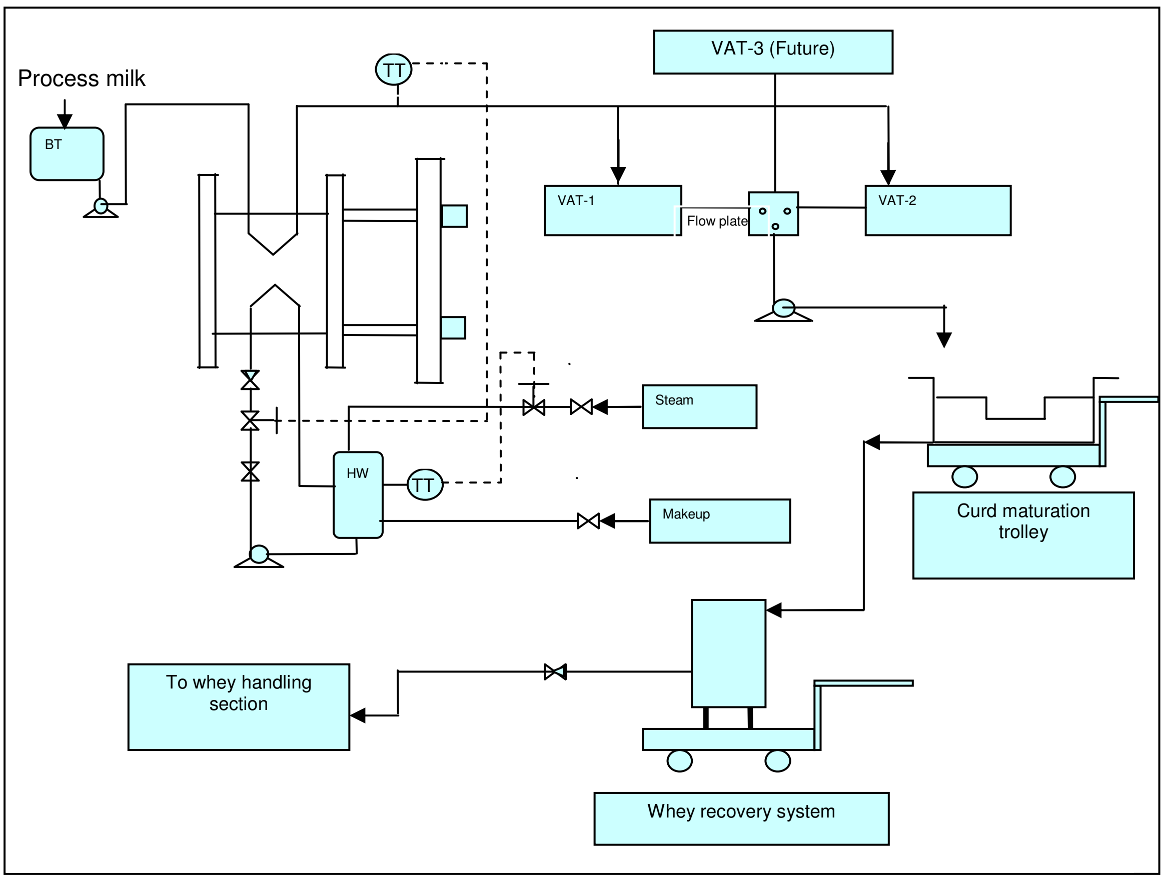

Figure: 43, First step of Cheese preparation (Cutting and cooking)

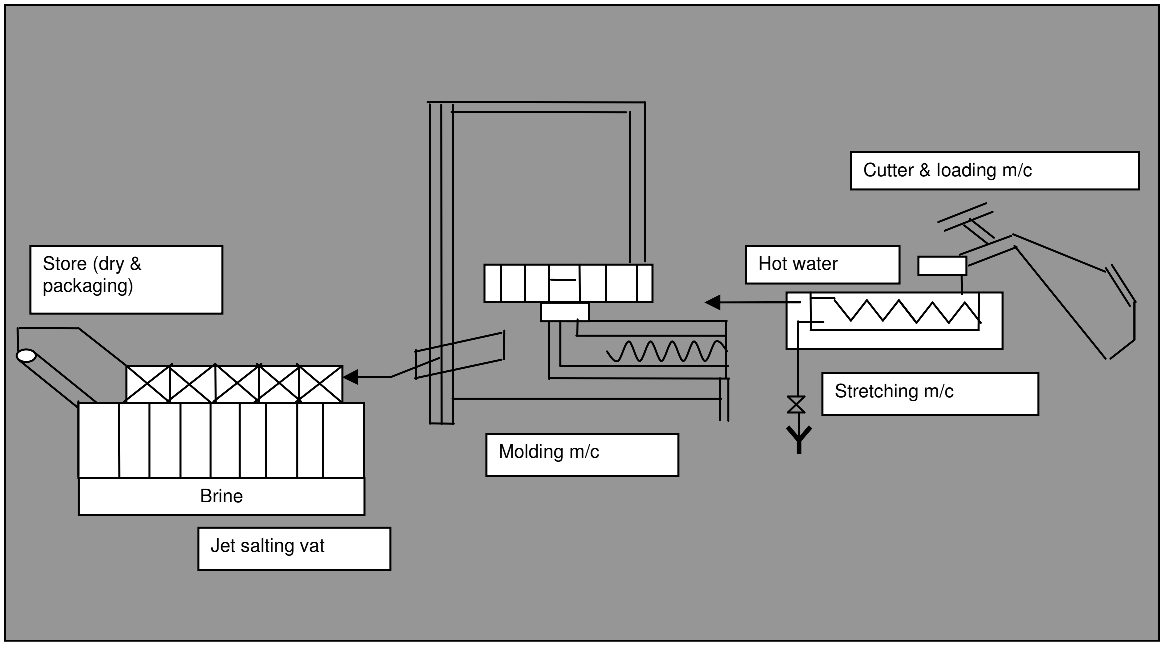

Figure: 44, Second step of Cheese preparation (Stretching & molding)

Block diagram:

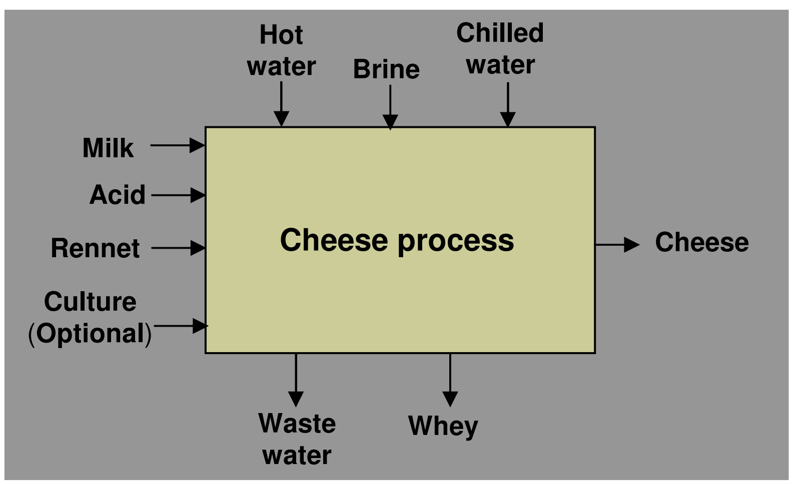

Figure: 45, Cheese section block diagram

Waste stream was identified as "WHEY". The yield of cheese is 10%, so rest 90% of milk is converted to a liquid called as WHEY.

Effects of whey:

1 Economic loss

2 Environmental loss **(70,000 mg COD/lit)**

"Whey is produced during the production of cheese & casein"

Table: 12, Characterization of Whey

Component %	Sweet Whey (Dry)	Sweet Whey (Fluid)	Acid Whey (Dry)	Acid Whey (Fluid)
Total solid	96.5	6.35	96.0	6.5
Moisture	3.5	93.7	4.0	93.5
Lactose	75.0	4.85	67.4	4.9
Protein	13.4	0.8	12.5	0.75
Fat	0.8	0.5	0.6	0.04
Lactic acid	0.2	0.05	4.2	0.4
Ash	7.3	0.5	11.8	0.8
Ph	5.5 – 6.0	5.5 – 6.0	4.0 – 4.5	4.0 – 4.5

Quantification of waste streams:

Quantity = 90% of milk processed

Milk processed = 30,000 liters / day

So whey produced = 30,000 * 0.9

= 27,000 lit / day

= 98, 55,000 lit / year

Characterization of waste stream:

Table: 13, Sampling of Whey produced in MDG

Item	Fat	SNF	PH
Whey 1	0.63	5.73	5.54
Whey 2	0.94	5.67	5.48
Whey 3	0.37	5.77	5.45
Whey 4	0.39	5.73	5.46

Implementation of CP opportunity:

- Methane production from Cheese whey
- Whey concentrate production
- Whey powder production
- Recovery of whey elements by membrane application

After the quantification of waste stream i.e. Whey we need to go for the utilization part of it and we have got many solutions for it;

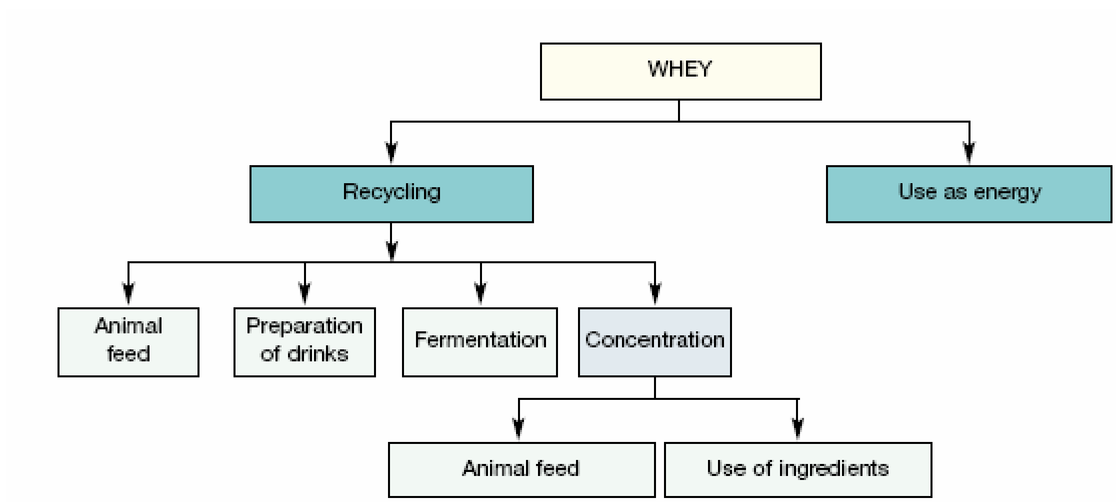

Figure: 46, Uses of whey

Cleaner production exercise 4

4.5. ICE CREAM SECTION

Baseline data collection:

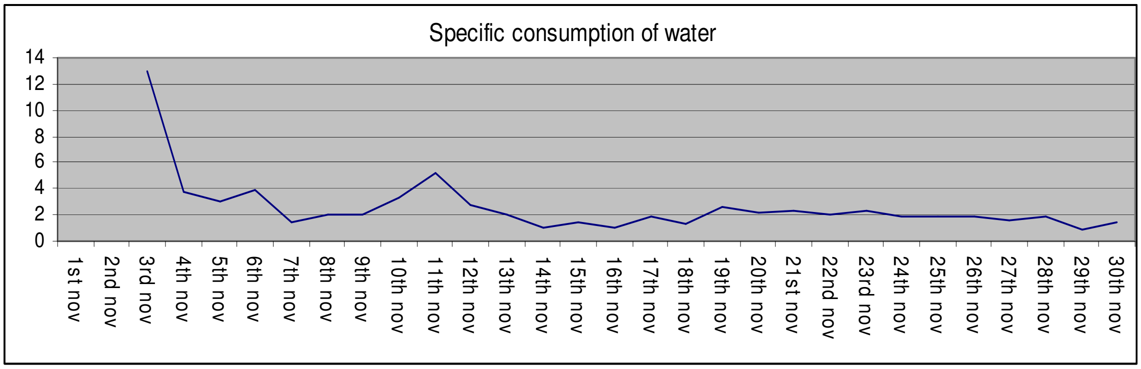

Figure: 47, Water consumption pattern

This is the data for Nov'05 and they have been improving all through but still there were a few points to be discussed with Mr. Mathur (In charge).

Water uses:

1 CIP

2 Floor washing

3 Preparation of mix

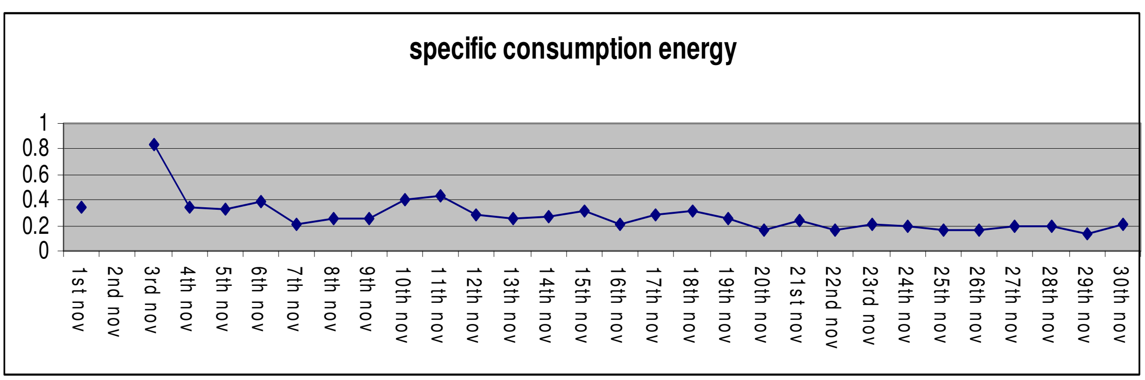

Figure: 48, Energy consumption pattern

It has been steady all through again but a few case studies of CP application in Ice cream factory and the benchmark data was given to them for further improvement.

Process description:

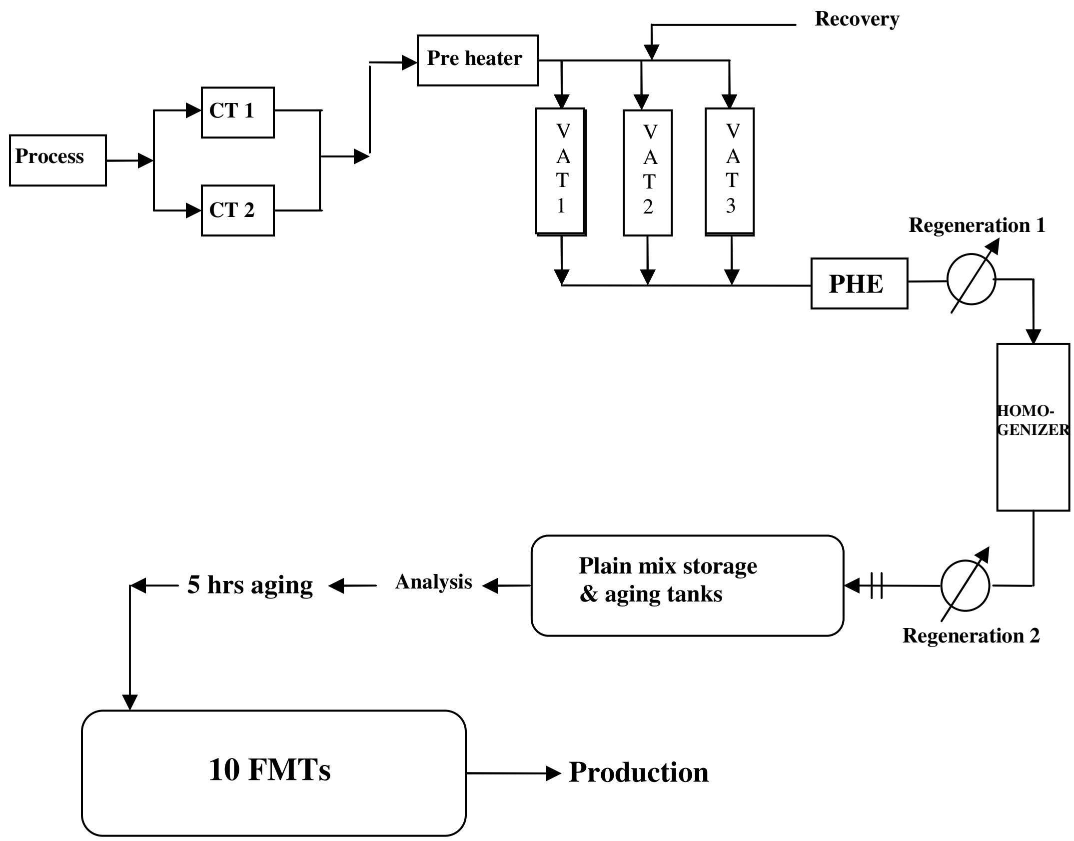

Figure: 49, Flow diagram of ice cream mix preparation

High fat milk (18 to 24% fat) from process section is supplied to the CT's (Cream storage tanks) where it is sampled and verified and then it is heated to 65-70^{0}C and all the ingredients are added to it to make the ice cream mix.

The ingredients are:

- High fat milk
- SMP or WMP
- Sugar
- Stabilizer

Then this is blended by tri-blender as per the recipe and either SMP (Skimmed milk powder) or WMP (Whole milk powder) is used. After making the mix it is taken for pasteurization and is kept at 85^0C for 25 seconds in the holding section (Regeneration 1 to regeneration 2) and then it is stored in the storage tanks then it is sampled to check the recipe and after that is kept for 5 hrs of aging. After that it is taken to FMT's and then it could be taken to any of freezers (total 8 freezers) and ultimately ice cream is formed and is taken to the hardening tunnel which makes the temperature – 15^0C from – 5^0C and then it is stored for dispatch.

Waste streams identification:

The waste streams identified in the section and they were most of time not because of some technological mistakes but were mostly attributed to human mistakes.
The points of wastages were

- CIP flushes for different tanks and installations
- Product loss due to mishandling
- Running water pipes
- Leaks & spills

Waste streams quantification, characterization and cost assigning

As the waste streams in the section were the consequences of human error most of the times so they were not regular or continuous and then it was almost impossible to quantify them or draw a trend curve for them as to characterize them.

CP opportunity and focus area selection

After all the data collection and analysis the focus area for pollution prevention was to recover the product and wastewater from the section.

Implementation of CP opportunity

As per the observation and available literature on ice cream production it was found that with the available technology only GHK and process modifications were the CP tools those could be applied in the considered section.

The recommendation & observations were as follows:

1. CIP flush was 1^{st} made to fall on the floor and then it was cleaned with the running water which consumes a lot of water. This was readily accepted by Mr. Mathur and a hose pipe was fitted to the pipe to get the flush in the gutter directly rather than on the floor as per my recommendation.
2. There were leaks in the tanks and valves and when I showed the possible loss of water by them the maintenance people were asked to repair it immediately and it was done.
3. An oil drum was getting heated by a pipe of running hot water by contacting the drum outer surface with the stream of hot water.
4. They have a machine for making Candy ice cream and after the formation of ice cream it falls into the mould of a conveyer which carries ice cream to the packing machine. As the candy falls onto the conveyer sometimes it takes some awkward orientation and it is supposed to be the responsibility of an operator by making it upside down or otherwise. The observation was that the operator was handling it with a wooden stick which can cause the damage to the product. It was brought to the notice of Mr. Mathur (In charge) and immediate instruction was forwarded to the operators.
5. Operators were not using the masks provided.

A few more, common observations were discussed and almost everything was **accepted and implemented** with immediate effect.

Sampling at process section:

[Figure 38, View inside the tanker]

[Figure 39, Labors taking samples]

[Figure 40, Samples placed in the Laboratory in Dairy]

CHAPTER 5 ANALYSIS & RESULTS

5.1. BASIS FOR ANALYSIS

The presented work is about the pollution problems of dairy industries and is about giving the solution along the lines of pollution prevention at the source. There are various methods and methodology available in the name of pollution prevention but out of them the strongest tools and methodology of Cleaner production is selected.

The need of the hour for dairy industries is the pollution prevention and resource conservation and as both of these practices complement each other so doing one of them should serve the other purpose. On the basis of above thoughts the tools of cleaner production were applied to a multi-product dairy as to

1. Find the potential for improvements
2. To suggest the technology/procedures/practices which will serve the objectives of pollution prevention and resource conservation

The ultimate aim of the exercise is to bring in the importance and relevance of the benchmark data to the industries and to find out the efficiency of management in the considered dairy.

Methodology:

We needed a reference compass to gauge the performance of the considered dairy in terms of resource utilization and pollution generation i.e. Benchmark data.

Benchmarking is a way to identify impending problems and assist in pointing a business toward the opportunities that exist for improving performance. Using objective measures of performance assists in focusing attention where attention is most needed and allows for learning, which should translate into continuous improvement within an organization.

"Benchmarking provides the compass readings and navigational details for attaining competitive excellence".

It's an effort to use the benchmarks for BOD and waste water load for a real multi-product dairy. Then the results are incorporated to compare it with the industry standards of losses and compare it with the references available to portray the actual condition prevailing in the considered dairy. As in the considered dairy the monitoring of waste from the individual sections was not possible so to develop a flow chart of the entire organization mentioning waste water and BOD contribution (which was a requisite for CP application), the benchmark data and the philosophy of waste audit is used to assign the loads of individual section.

Observations and base line data collection:

Along the lines and methodology of Cleaner production it is a proven fact that observations of the company can straight away give you an idea about the organization and its resource status. So we start with the observational evidences.

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CHAPTER 6 CONCLUSION

6.1. CONCLUSION

From the analysis and then by virtue of subsequent results, the understanding of the organization and its resource status is clear and on the basis of that following points can be concluded:

1. **Wastage** of **milk** is more than any standard.
2. Loss is **more** than the industry standard.
3. **GHK** is supposed to be in written procedures for every section and is essential for the company.
4. **Dry clean up** is required/ No washing of spillage.
5. Permanent **solution** for **whey.**
6. Maximum **CIP flushes** should be recycled.
7. Each section should undergo a **waste audit.**
8. Monetary **loss** to the company is **high.**
9. **Water** consumption status can further be improved.

For the dairy, the zest of the matter is that there is an enormous scope of improvement especially in the organic load context (BOD) as it is beyond any reference gauge even and by virtue of which the dairy is incurring a huge monetary loss, so it is concluded that the management needs to reconsider its strategy regarding the resource conservation and immediate action should be taken to take the organization to the forte.

CHAPTER 7 RECOMMENDATIONS/ POINTS TO FOCUS

7.1 POINTS TO FOCUS

By references and observation, the sources of waste in the dairy are

Table: 24, Description of sources for wasteful practices

Number	Description of source
1	Cleaning out product remaining in tankers, piping, tanks, and other equipments
2	Spillage produced by leaks, overflows, equipment malfunction or careless handling
3	Processing losses, including - product wasted during HTST pasteurizer, shutdown and start up - evaporator entrainment - product change over in filling machines - splashing and container breakage in automatic packaging equipment
4	Wastage of spoiled products, returned products or by-products such as whey
5	Detergents and other compounds used in cleaning and sanitizing
6	Entrainment of lubricants from conveyers and other equipments in the waste water from cleaning operation
7	Routine operation of toilets, washrooms and canteen facility at the dairy

The first five elements in the table are responsible for almost 94% of the total BOD received at the ETP and it comprises of pure milk loss.

Justification for reasons to losses:

1. **Product remaining in the tankers, vats and pipes:**

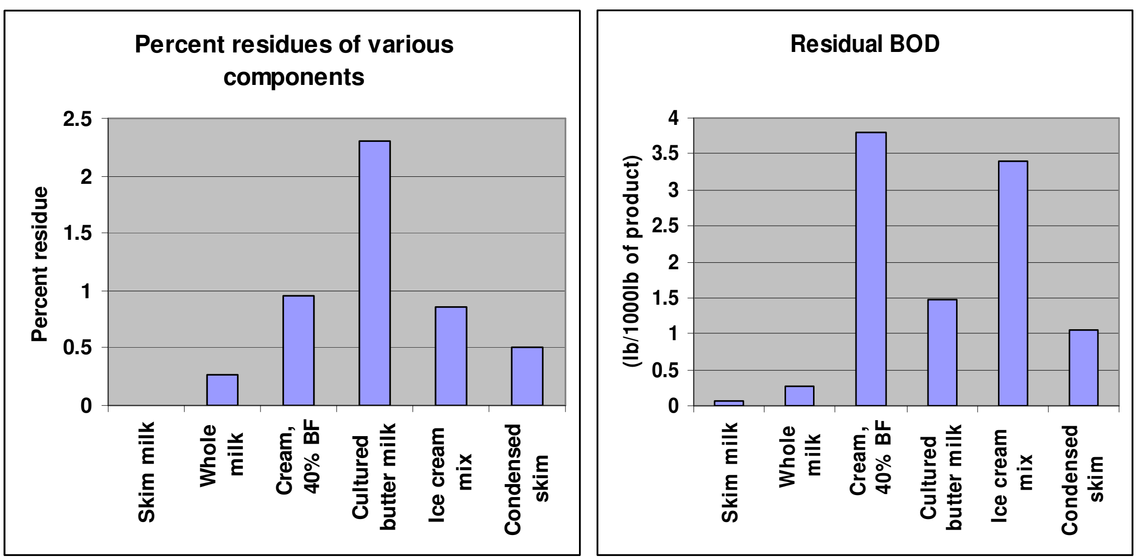
The following details are deciding the degree of losses for different components in dairy industries and then in turn the need to recover them for cost and pollution concern.

Justification: The basic parameter chosen for deciding the percent component residue remaining in the tank, vats or pipes is the viscosity of individual components.

Table: 25, Component viscosity [10]

Component	Viscosity(CP)
Skim milk	1.4
Whole milk	2
Cream, 40% BF	91
Cultured butter milk	500
Ice cream mix	121
Condensed skim	-

Now as per the information available the conclusion about most polluting and which is required to be recovered 1st of all can be given.



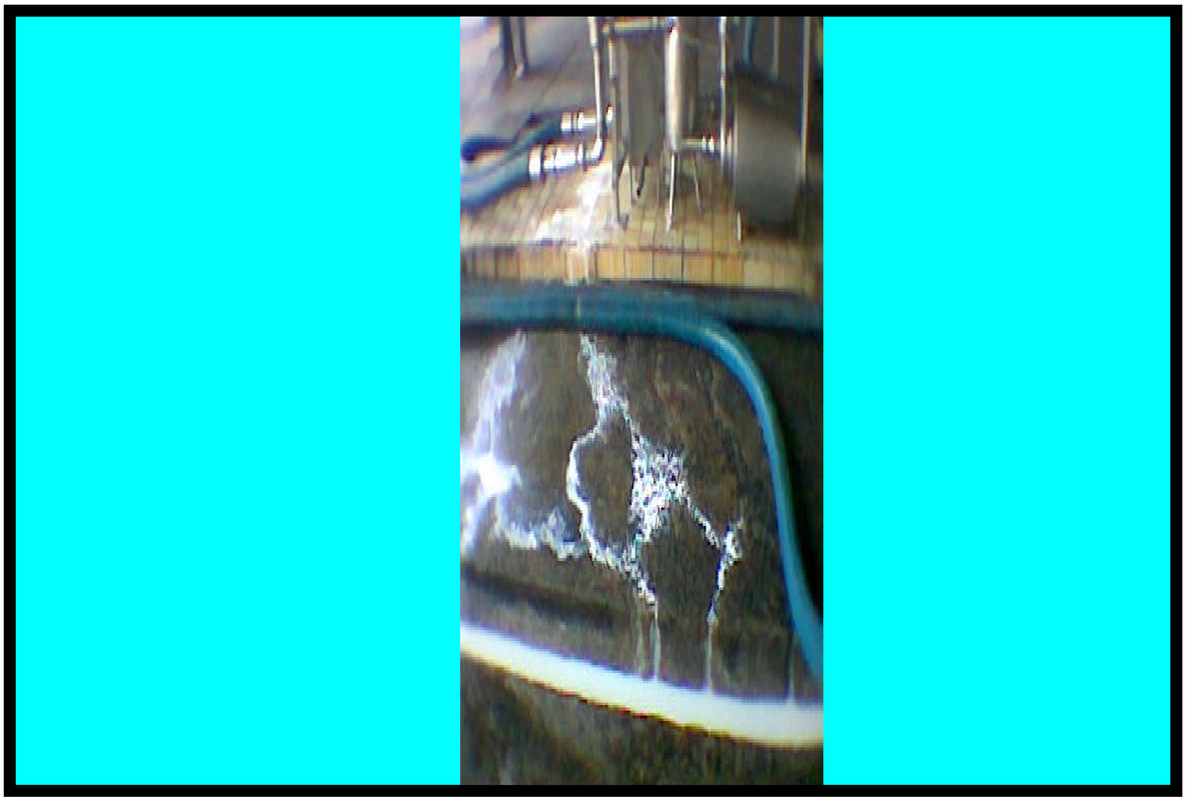
[Figure 65, Comparative charts for different milk products] [10]

So the priority order for recovering the components will be

- Cream, 40% BF
- Ice cream mix
- Condensed milk
- Whole milk
- Skim milk

2. Spillage produced by leaks, overflows and careless handling:

Now it is the source which can only be controlled by disciplined and efficient organizational performance and in turn it will be minimized by itself. So it is more about the control of losses by good management practices. And they are given to individual sections in form of literature.



[Figure 66, visible losses in the dairy]

The photographs above show the losses which can be controlled and most of them are already controlled. From the above pictures it can easily be understood that these losses are the consequences of mistakes at operator level so it does not require any high end solutions, but can be prevented simply by proper training and by providing written procedures to carry out the daily operations.

As it is the view from a single section so saving potential in the entire dairy is enormous and it definitely is possible.

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CHAPTER 8 FUTURE WORK

After the exercises of CP in the dairy it was the time to see further scope of work in the organization for the purpose of continuous improvement, which is in line with the objective of Cleaner Production philosophy. To find out the scope for improvement it is a need to dismantle and analyze the constraints and horizons available with the organization and fortunately there is an analytical tool available for it in the management world i.e. **SWOT** analysis.

8.1. SWOT ANALYSIS (For Resource conservation scope) [20]

It is purely a management tool to evaluate the status of the organization and with the help of this the effort is been made to portray the picture of resource status in the dairy, as to see the feasibility of recommended procedures and their possibility of implementation. The points highlighted in the analysis definitely depend upon the feasibility or the practical realization status of the considered option when it comes to execute it.

Strengths:

1. **Demand profile:** Absolutely optimistic
2. **Flexibility of product mix:** Tremendous, with balancing equipment, you can keep on adding to your product line.
3. A **competitive** and **visionary management**
4. **Technical manpower:** Professionally-trained, technical human resource pool, Best of industry talents in form of team leaders
5. A **great team** as a whole

Weaknesses:

1. Absence of **specialized data analysis** department
2. Absence of **waste monitoring** facility
3. Absence of **waste stream segregation**
4. No system to **quantify waste** from individual sections
5. Absence of **R&D** department

Opportunities:

Failure is never final, and success never ending". Dr Kurien bears out this statement perfectly. He entered the industry when there were only threats. He met failure head-on, and now he clearly is an example of 'never ending successes.

1. **Innovation** of new products by using currently wasted resource
2. Full utilization of by products such as whey
3. Reduction of operating capital for treatment of waste by converting the waste into valuable product, at the source itself
4. **Capitalization** on the nutritional value of milk and by products to develop **new products**

Threats:

1. Innovated product feasible technically but no market feasibility or vice-versa
2. Economic feasibility of new product
3. Resistance from market in acceptance/product positioning for new products

The study of this **SWOT** analysis shows that the 'strengths' and 'opportunities' far outweigh 'weaknesses' and 'threats'. Strengths and opportunities are fundamental and weaknesses and threats are transitory. So the organization stands a great chance of practicing anything they want, in order to improve the efficiency and productivity as to take the organization to the new heights.

8.2. Proposed management strategy:

Objective: The objective of this strategy is to conservation of resources, to increase the productivity and minimization of waste, keeping in view the weaknesses of the company.

The proposed management strategy will be executed by a team including,

1. Production departments
2. ETP staff
3. Management or Management representative

The strategy is oriented to find the real status of the dairy in terms of resource utilization and to find out the conservation potential for the same. The jobs and job responsibilities assigned are as follows:

From production side:

1. Perfect mass balances/day till packaging
2. Actual resource consumption
3. All loss quantification, Find the real loss/day
4. Tally your loss to the BOD value from ETP staff for your section
5. Get the data to the management representative

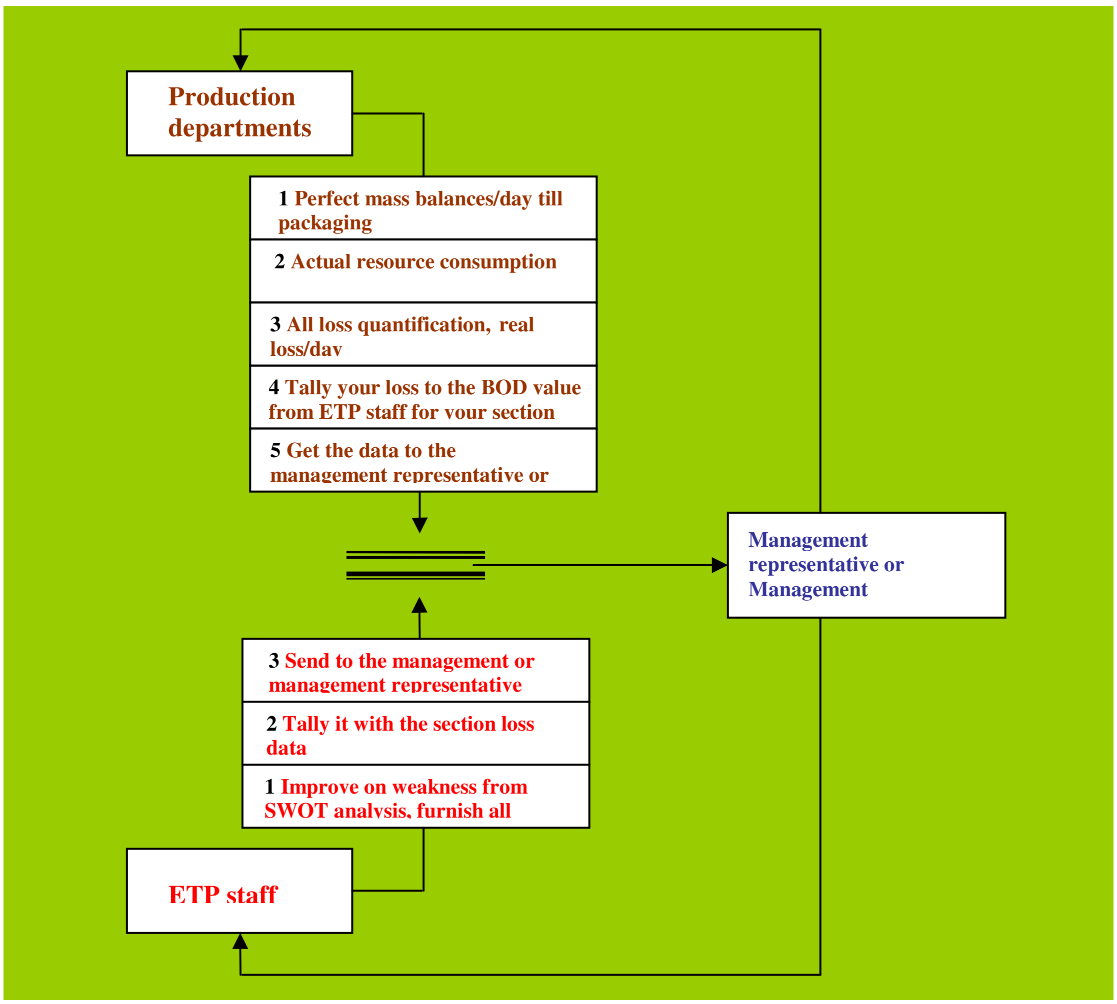
From ETP side:

From the weaknesses of **SWOT** analysis

1. Improve on , furnish all data/day
   - Enable a waste monitoring facility (section and whole)
   - Use the system (self developed or references) to quantify environmental load
2. Tally it with the section loss data
3. Equate it and send to the management representative

For management or the management representative:

1. Issue the information/agenda
2. Compare with benchmarks for all sections
3. Cross check waste load from section loss/d and ETP's BOD value/d (per section & whole dairy)
4. See the difference if any and give the feed back to the respective member of the team



[Figure: 70, proposed management strategy]

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