MODULE 4. PLANNING AND PRINCIPLE OF DAIRY PLANT LAYOUT

Lesson 10

Importance of planning and principles of dairy plant design

10.1 INTRODUCTION

Dairy Plants are engaged in processing of milk and manufacture of various dairy products. It is estimated that about 20-25 % of the milk produced in India is being processed by organized dairy plants. The planning of dairy and principles of dairy plant layout mainly depends on the type of the products manufactured and the capacity of the plant. It is necessary to consider both the supply of raw milk and market for processed milk. The earlier concept of locating liquid milk plant near the urban areas is changing and the trend is to locate the plant where the availability of milk is more. The availability of manpower, transportation, source of water and disposal of effluent are also to be considered for the planning of dairy plant. Dairy processing plants can be divided into two categories.

· Fluid milk processing plants involving the pasteurization, flavored milk, butter milk, dahi, paneer etc.

· Composite product plant engaged in processing of milk and manufacture of different products such as cheese, butter, milk powders, frozen products etc.

Dairy processing aspects are changing continually and many new technologies are being used in dairy industry in order to improve productivity, use of automation, manufacture of value added products and conservation of energy.

10.2 Raw Milk Collection and Reception

The milk is collected from the milk producers' society and the collected milk in milk cans is transported through truck to milk processing plants. As the time spent for transportation of milk from remote places together with warm environmental conditions, the sour milk percentage was higher. Therefore, the concept of establishing chilling center at appropriate location came in to existence to cool the milk in the respective chilling center and the chilled milk is transported to the milk processing plant. When the milk is received in cans, it requires milk reception dock having facility of milk weighing, can conveyer, can washer etc. is required at planning stage of dairy plant. Conversely, chilled milk collection and transportation in insulated tanker requires bay to unload the milk from the tanker. The present trend is to chill the milk immediately as soon as it is received at the milk producers' society by using BMC which has improved the quality of raw milk received on the plant. Therefore, based on the way of reception of milk, different principles are required for dairy plant layout.

The capacity of the plant and level of automation required in the plant are also important in design of dairy plant. It is also necessary to consider CIP method at the stage of planning a dairy plant. Source of water and its distribution is a factor to be considered at planning stage of a dairy plant. Depending on the method of milk collection and reception, it is necessary to plan the reception dock.

10.3 Processing of milk

The equipments such as milk pasteurizer, separator, homogenizer, cream separator, etc. are required to be installed in the processing room. The planning of this section is carefully done considering size of the

equipments and working space required for ease of operation. Cream separator and bactofugation require more working space in order to dismantle and assemble these equipments. This section also requires to accommodate milk pipelines to transfer the milk. In many dairies, the cream separation and clarification is carried out using self-cleaning separators. The separator also discharges sediment consisting of dirt particles, udder cells, and bacteria, and leucocytes, which normally is collected or led to the wastewater drain.

10.4 Manufacture of dairy products

The product mix of the dairy is very vital to decide the planning of dairy plant. The product mix may be cheese, butter, milk powders, etc. The planning of various sections considering size of equipment, space requirement etc. should be considered. The housing of milk condensing plant and spray drying plant requires detailed specifications at the stage of planning of dairy plant. The height of the building and provision to access all components of the condensing and drying plant is one of the important requirements in planning of this section. All heavy equipment such as batch type of butter churn may be installed on ground floor with adequate strong foundation.

10.5 Importance of planning and principles of dairy plant design

It is very difficult to develop perfect plant layout for all categories of equipment and services. The ideas of several persons are usually required to make a planning of a dairy building. The provision of future requirements is also to be considered as far as possible. It is noticed in many plants that it is not possible to install a single HTST plant in the existing building to handle more milk. Therefore, it is necessary to consider additional capacity requirement for the next 5-7 years. The adequate provision for offices, laboratory, storage etc. is one of the essential requirements in the planning of dairy plant. The dairy plant layout involves room arrangements and equipment layout considering all technical aspects.

Thus, planning is the way of proceeding or scheme of arrangement for executing any work or project. Planning of dairy plant and adopting principles of design play an important role in the successful running of a dairy plant with desired quality and quantity of output. A well planned design using salient principles of planning helps in following ways.

· Convenience of working

· Ease of handling the operation

· Easy maintenance

· Safety

· Better productivity and labor saving

Advantages of planning and principle of dairy plant designing are mentioned.

· Better hygienic conditions and minimum losses.

· Accommodation of future expansion

· Reduction in processing cost

· Optimal height reception dock improves the working efficiency of worker

· Safety of persons working in the plant.

· Better use of services such as water, electricity, refrigeration, air supply etc.

· Better space utilization for equipment and services. .

· Quick communication with different sections of dairy.

· Efficient utilization of manpower.

· Efficient movement of product within the plant and dispatch

· Energy saving

· Saving on building cost

Utilizing principles of planning and applying them for plant construction leads to economical and effective running of plant. The use of scientific, technical, and logical knowledge can form a model plant for dairy. The planning of dairy plant is more important as compared to other industrial plant due to the requirement of hygienic conditions and perishable nature of milk and milk products.

10.6 Dairy building planning

The elevation of dairy building should give advertizing image to the people. The form and shape of dairy building is important as it affects the public reaction as well as upkeep and initial cost. In addition to several technical considerations, marketing of dairy products needs good site selection and attractive building design. Appearance and look are the primary factors affecting the marketing of the products. If a brand is having a typical pattern of building replicated at many places the building pattern itself may become identification for the brand of the organization.

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Lesson 11

Dairy building planning

11.1 INTRODUCTION

The planning of dairy building is the main activities for establishment of dairy plant. Planning is the way of proceeding or scheme of arrangement for executing any work or project. Designing a dairy plant layout is a joint venture of Architects, Dairy Managers, Dairy Engineers and Administrators. It is necessary to consider all technical aspects and economical considerations. The ideas of several technocrats are sought and based on the suggestions of all concerned, actual building planning is worked out. The requirement of utilities such as water, refrigeration, steam, electricity etc. is carefully estimated while planning a dairy. The planning of dairy building depends on capacity, product mix, size of equipments, work space to be kept, future expansion requirement etc. There is no any blue print to be used for design of dairy building. It varies from plant to plant even though the capacity and product mix is the same.

11.2 Dairy plant layout

The main objective of dairy plant layout is to design the dairy plant to carry out all dairy processing operations. The knowledge of estimating the requirement of various equipments, location of equipments in different sections, space requirement for equipment and the general civil aspects of building construction. The engineer should have very clear and complete understanding of requirement and management policies. The management policies decide the future expansion requirement of a dairy plant. Management decision with respect to the addition of new of products is important to be considered at the stage of dairy plant layout. It also includes process schedule to be followed and requirement of different utilities.

A well designed layout must facilitate production operations, minimize material handling maintain flexibility of the operation for alteration and expansion, minimize investment in equipment, make economical use of floor area, promote effective utilization of the labor and provide for employee convenience and comfort.

It is up-most important to design optimum size of dairy building. Some enterpriser engages an architect to prepare the plant layout for an attractive design and consult dairy equipment manufacturers for ideas regarding latest machinery. However, involvement of dairy engineer in the layout is very vital to take care of all necessary requirements. It is advisable to make judicial use of land available and optimum cost in construction of building.

11.3 Important factors for planning of dairy building

The following are the basic factors which must be considered before planning the dairy building.

- Milk handling capacity and variation in milk handled every day.
- Method of milk collection and transportation
- Design of milk processing section.
- Method of milk packaging.
- Way of milk distribution to consumers
- Source of electric power supply, water supply and waste water disposal.
- Type of fuel for boiler.
- Provision for subsequent future expansion.
- Transportation facilities and conditions of road

The source of water throughout the year is very important in design of the plant. Water may be distributed by gravity system or hydro-flow system using G.I. pipelines. If power shut down is frequent, then provision should be made for standby availability of electric power. It may not be possible for large plant to have diesel electric power generator for total load of the plant. But partial requirement of electrical power generator facilities is necessary to carry out essential low power consuming operations. The method of effluent treatment system is to be considered at the design stage of the building and provision is made for disposal of treated water.

11.4 Planning of dairy processing schedule

Process scheduling means arranging the flow of products through various operations in the plant in order to achieve maximum use equipment and labor, and the processing of the products is accomplished in the shortest possible time with minimum delays between processing of different products.

11.5 Operational layouts

Operational layouts describe operations which take place in processing or manufacture of different products. All operations involved are represented diagrammatically in chronological way (sequence-wise flow diagram) which can be easily understood by a layman. Even operational layouts can be shown in pictorial views or three dimensional layouts. Such layouts would help to understand the sequence of operations to be followed for the manufacture of various products.

11.6 Principles of dairy layout

A dairy plan engineer should try to incorporate all the fundamental aspects listed below. This would help in performing dairy activities economically and efficiently.

1. The milk path should be as short as possible. This will minimize the cost of pipeline and cleaning time.

2. Reception and dispatch must be arranged in such a way that congestion of transport vehicles is avoided.

3. As general guidelines, a small dairy may have reception and dispatch on one dock but it is necessary to have them separate for large dairy plants.

4. Where space is available, single storey building is most suited. The plan may have a rectangular shape with roads on all sides.

5. Location of milk silo outside the building area may save space and construction cost. This is widely followed in almost all dairy plants.

6. As far as possible refrigeration and boiler section are kept little away on the side of the building on ground floor. Refrigeration machinery room should be near the process room and cold store to reduce the piping cost and pressure drop.

7. Laboratory should have easy approach to reception room and processing room.

8. Separate building block for administrative offices

11.7 Product storage

There are two types of storage rooms required for dairy plants.

· Products stored at room temperature e.g. milk powder

· Products stored at lower temperature e.g. milk, butter, ice-cream, cheese etc.

The design of cold storages requires careful planning to store the product at lower temperature. Pasteurized milk is stored at 3-4 ^{0} C while ice-cream is stored at – 25 ^{0} C. Therefore, separate cold storages are required for different dairy products. The capacity of cold storage and cooling load calculations are necessary for the design of the cold storages. The frequency of dispatch and period of storage required are essentially required for design of the cold storages.

11.8 Selection of equipment

The selection of equipments before the actual design of building is necessary to decide the space and input required for these equipments. Some equipments are very large which are required to be installed before the construction of walls of the building. The distance to be kept between the equipments is also important to decide the ease of opening the equipment for maintenance purpose. Specifications of each equipment is necessary to be decided at the time of planning of dairy building.

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Lesson 12

Preparation of process schedule

12. 1 INTRODUCTION:

Process schedule is one of the important activity of planning, before diverting milk to different section for product manufacturing. It is prepared well in advance to give instructions to boiler operator, refrigeration plant operator, different process section in charge to plan for the activity of different unit operations for processing the milk to have smooth operation of the process. It also helps to prevent product losses and to have efficient use of equipments, energy and water.

12.2 PLANNING FOR PROCESS SCHEDULE

Preparation of process schedule is one of the important tasks in dairy for a technologist in order to prevent losses in terms of manpower, energy, services, and time. A well planned time schedule will help in preventing losses as well aid in routine work viz. Maintenance, breakdown, establishment etc.

After careful consideration of dairy building planning mentioned above, a process scheduled layout is drawn. Process scheduling means arranging the flow of products through various operations in the plant in such an order that maximizes use of all labor and equipment, and the processing of the products is accomplished in the shortest possible time with minimum delays between processing of different products.

First of all "Basis of Dairy Layout' is drawn according to item of manufacturer to decide definite line flow. To this skeleton layout are added as other information, such as operating rates, storage capacity, raw material required, man power required etc. as each section of plant is considered in relation to the equipment available.

Planning for operations involved in processing of any dairy product has to be done in advance so that maximum use is made of men and material with little waste of time. Process schedule which is more or less work plan ensures that the proposed operation will run smoothly. It provides the basic information from which schedule of service requirements and list of equipment can be made. Time and operation graph can be made which will indicate at what time particular operation has to be performed. It may be noted that all operation for manufacture of any particular dairy product cannot be started at time. There must be a sequence for performing an operation in the plant and that is why the process schedule is required.

The features of the plant considered during preparation of process schedule are:

· Reception capacity,

· Unit processing cost,

· Frequency of CIP,

· Installed capacity of the plant,

· Handling capacity of the plant,

· Running hours and Idol time of plant,

· Quantity of milk received in different season,

· Capacity of the various equipments installed for the processing and production purpose viz. PHE, SEPARARTOS, PUMPS, CATLES, VAT, etc;

· Capacity of the services and providing machines viz. Air compressor, refrigeration, boiler, water, ETP, etc;

· Product dispatch timing

12.3 Example of a Process schedule of a milk-processing plant handling approximately 1.5 lakh lit of milk in morning and evening:

Milk is received two times in a day approximately 82,000 lit in evening and 68,000 lit in the morning.

Considering the processing capacity of the plant 20,000 lit /hr.

Morning

Sr. No	Process	Start Time	End Time	Total Time
1	Sterilization of plant	7:30	8:30	01:00
2	Milk processing	8:30	13:30	05:00
3	CIP	13:30	16:40	04:10
	Hot water Rinsing	13:30	13:45	00:15
	Lye circulation	13:50	14:50	01:00
	Hot water Rinsing	15:00	15:15	00:15
	Acid circulation	15:20	15:50	00:30
	Hot water Rinsing	16:00	16:15	00:15
	Lye circulation	16:20	16:30	00:10
	Hot water Rinsing	16:30	16:40	00:10

Evening

Sr. No	Process	Start Time	End Time	Total Time
1	Milk processing	20:30	01:00	04:30
2	CIP	01:00	16:40	04:10
	Hot water Rinsing	01:00	01:15	00:15
	Lye circulation	01:15	02:15	01:00
	Hot water Rinsing	02:15	02:30	00:15
	Acid circulation	02:35	03:05	00:30
	Hot water Rinsing	03:10	03:25	00:15
	Lye circulation	03:30	03:40	00:10
	Hot water Rinsing	03:40	03:50	00:10

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Lesson 13

Space requirement for dairy plant

13.1 Introduction

The space requirement for dairy plant should be estimated for its functional design to have smooth operation. The space requirement of entire dairy plant is estimated by adopting principles of dairy plant layout. It is a basic requirement to estimate the total area required for the dairy plant which include building area, parking, movement of vehicles, roads, ETP etc. The type of layout varies considerably for the same plant after having estimated the space and area requirements for different sections. Land requirement is one of the basic cost factors of the plant and land cost has increased considerably in last decades. Therefore, it is important to design the plant with cost effectiveness. According to size and shape of the plot, the most befitting type of layout is selected and all sections are planned in accordance requirements.

13.2 Area and space requirements for milk plants

Space required for equipment depends upon the capacity and dimensions of the equipment. There is no any rigid rule to decide the area of various sections. It mainly depends on the idea and judgment of engineer who is designing the dairy plant. General guidelines are given below to estimate the size of different sections.

Table: 13.1 Approximate area and space requirement for dairy equipment

Milk reception dock (single conveyer and weighing pan)	7 m x 10 to 14 m
Can washer	5m x 5 m (rotary can washer), 5m x 20 to 22 m
Horizontal milk tank, 10.000 liters	3m x 5m
Horizontal milk tank, 20.000 liters	4m x 7 m
Vertical tank, 10,000 liters	4 m x 4 m
Process room area, minimum	5-6 times the area of equipment
HTST pasteurizer, 10,000 liters/h	25-30 m^2
Space between two equipment	1-1.5 m
Space between two tanks	1 m
Area of small dairy, 10,000 to 15,000 litres/day	200 m^2
Area of medium size dairy, 40,000 to 50,000 litres/day	300-400 m^2
Area of larger size dairy, 50,000 to 100,000 litres/day	400-600 m^2

Note: For higher rates, equipment will have to be duplicated and upto 60% extra space must be allowed.

Bulk milk storage:

The space requirement for bulk milk storage can be estimated based on the type of storage vessels used (horizontal storage tank, vertical storage tank, silo etc). The space requirement is estimated based on the working space required around the tanks and necessary equipments installed around the tank. It should also facilitate the cleaning operation, manually or CIP.

Table: 13.2 The approximate space required to accommodate tanks and the associated piping,

Particulars	Area
Approximate plant area	1 to 2 sq.ft./gallon of milk handled per day
Plant area for vbolumes under 20,000 pounds/day	3 sq. ft./gallon 1 IMP gallon=1.20 U.S. gl.
Refrigerated milk storatge room area Approximate	5.25 gallons/sq.ft.(for round bottles) gallon milk/sq.ft.(for square bottles)
Process room area minimum	A=5 a, where a = area of the equipment space
Minimum space between the equipment	3 ft. (90 cm)
Working space around the equipment	3 ft. (90 cm)
Minimum space between storage tanks	2 ft. (60 cm)
Processing room ceiling height (min.) Recommended height	10 ft. (300 cm) 12 to 15 ft. (366 cm to 458 cm)
Processing room ceiling height if visitor's gallery is to be provided	20 to 25 ft. (600 cm to 750 cm)
Height of cold storage room (min.)	8 ft. 6 inch (260 cm)
Bottle washing room area	Bottle washer area + crate washer area + space for conveyors + area of cold storage room
Dry storage area	25 per cent of the total plant area
The refrigeration machinery room (compressor, ice-builder etc.)	Fluid milk plants require 0.6 to 1.0 sq.ft. 0.6 to of floor area per hundred wt. Of milk handled/day. 1 sq.ft./112 lbs of milk handled per day
Boiler room	Excluding fuel storage, a boiler room will usually be from 0.4 to 0.8 sq.ft. for each 100 lbs of milk handled per day for a fluid milk operation.

Including access for cleaning is as follows:

Vertical tank 5,000 litres	3.5 m x 3.25 m
Horizontal tank 10,000 litres	3 m x 5 m
Horizontal tank 20,000	3.5 m x 7 m

13.3 Space requirement for different sections of dairy plant:

Allotment of the space for the specific section and to the specific plant and equipment is a matter of thinking so as to provide sufficient space to each plant and equipment for better functioning at the place for worker. Less space will create congested atmosphere and may cause accident at work in hurry some time; whereas unnecessarily providing more space may cause shortage of land in future and will cost more for maintaining cleanliness. So the space provided for a section should be sufficient enough for working freely and comfortably, which should be planned well with concept of expansion in future also. The sections like boiler, electricity and refrigeration should be kept in isolated area to safe guard the plant from accident and damages

The decisive factors which are to be kept in mind during construction of plant for space are:

· Size and the capacity of the equipment i.e. Height, length, width, etc.

· Type of operations to be carried out

· Future expansion

Table: 13.3 The approximate space requirement for different section and equipment are given below:

Sr No.	PARTICULARS		SPACE REQUIREMENT
1	Milk reception, Inspection, accumulation space and skim milk filling		5 x 10-14 m
	Tipping and weighing		5 x 6 m
	Rotary can washer (3-4 can/min)		4 x 4 m
	Straight through washer(8-10 can/min)		5 x 20 m
2	Overall space requirement: Upto 10,000-15,000 lit/day Upto 20,000-50,000 lit/day Upto 50,000-70,000 lit/day		 80-100 m^2 100-150 m^2 150-200 m^2
3	Bulk storage Vertical tank (5,000 lit.) Horizontal Tank (10,000 lit.) Horizontal tank (20,000 lit.)		 3.25 x 3.25 m 3 x 5 m 3.5 x 7 m
4	Milk processing HTST Plate pasteurizer(Upto 10,000 lit/hr) HTST Plate pasteurizer (with homogenizer or 2 separators) HTST Plate pasteurizer with homogenizer and 2 separators)		 25 m^2 36 m^2 48 m^2
5	By-productive section: Overall space requirement Upto 1,000 kg butter/day For 7,000 kg butter/day For 1,000 lit ice-cream/day For 5,000 lit ice-cream/day		 50 m^2 120 m^2 50 m^2 100 m^2
6	Milk powder section: Evaporator (1,000 lit of water/hr) Evaporator (9,000 lit of water/hr) Plate type evaporator (3,000 lit of water/hr) Horizontal spray drier (300 kg of water/hr) Vertical spray drier (500 kg of water/hr)		 30 m^2 x 3.5 m 50 m^2 x 9 m 50 m^2 x 3 m 80 m^2 x 8 m 80 m^2 x 14 m
7	Boiler section: <u>Boiler capacity</u> 500 kg/ hr 2,000 kg/ hr 5,000 kg/hr 7,500 kg/hr	 <u>Horizontal</u> 2 x 3 x 2.5 m 2.5 x 3 x 3 m 3 x 4 x 4 m 4 x 5 x 5 m	 <u>Vertical</u> 1.5 m^2 x 3 m 2 m^2 x 3.5 m 3 m^2 x 5.5 m -
8	Oil tank (50,000 lit.)		15 x 5 m

Lesson 14

Estimation of service requirements including peak load consideration.

14.1 Introduction

Estimation of service requirements is important to determine the capacity of equipments used for providing different services in the dairy plants. The major utilities of dairy plants are steam, refrigeration, electricity and air supply. It is necessary to know rate input services required for various equipments. The peak load can be estimated by for various services based on the operating schedule of the equipments. The peak load estimation is also important to make contract for connected electrical load of the dairy. The peak load requirement for steam, refrigeration, electricity and effluent treatment plant is very much necessary. Peak load is calculated based on capacity utilization of equipment and load conditions of cold store, ice bank tank and effluent treatment plant.

Dairy processing plants are traditionally divided into two separate categories for the purpose of production and energy statistical data presentation: fluid milk; and industrial milk. These two categories are described as follows:

· Fluid milk processing involves the pasteurization and processing of liquid milk for direct consumption, as well as creams, chocolate and other flavored milks, and buttermilk.

· Industrial milk processing involves the processing of milk into value-added products. These include cheese, butter, ice cream and other frozen products, condensed and evaporated milk, dried milk powder, yogurt and other cultured milk products. The milk used in the manufacture of industrial milk products is also pasteurized before processing.

For the purpose of this guide, six major generic process sequences (one fluid and five industrial) have been considered. These processes are:

o Fluid milk;

o Cultured products;

o Cheese;

o Butter;

o Ice cream and other frozen products;

o Evaporated/dried products

o Traditional Indian dairy product.

These generic process/product combinations were selected because they:

· Cover the wide range of product manufacturing activities undertaken;

· Represent the natural groupings of similar generic processes; and

· Coincide with the general process categories separately modelled in support of Hazard Analysis Critical Control Points (HACCP).

14.2 Steam Requirement

Steam requirement is calculated for processing and other purposes separately, while boiler for condensing and drying plant is selected separately, based on the calculation of steam requirement in the condensing and drying plants. After estimation of steam requirement of each equipment on hourly bases, time schedule diagram including each processing equipment is prepared to know the peak requirement of steam in the peak hours. Depending on the peak load requirements, steam pressure is maintained and boiler is started in advance to get required steam pressure and quantity of steam. The main steam line pressure is maintained higher than actually required during peak load hours, considering losses in the lines and number of bends in the line. The fluid milk plant requires approx. 0.25 to 0.4 kg of steam per liter of milk, while that of powder plant requires approx. 5 kg of steam per kg powder.

14.3 Refrigeration Requirement

Refrigeration requirement of dairy plant is mainly divided into two major categories (i) Chilling load and (ii) Cold storage load. Chilling load is referred to the chilled water requirement of different equipments during processing of different products. It is calculated based on the chilling requirement of different processes. The chilled water requirement of different processes can be met by Ice Bank Tank (IBT) or Ice Silo. IBT can be designed based on the total requirement of chilled water in the different processes in a day. The refrigeration plant for IBT can be operated during night hours (16 to 18 hours a day). The cold storages are required for different dairy products like ice cream, butter, cheese, milk etc. They are maintained at different temperatures and at different relative humidity depending on type of product to be stored. The cold storage refrigeration plant capacity is calculated based on consideration of different types of loads like product load, wall gain load, air change load, lighting load and miscellaneous load.

Time schedule for different processes which, requires chilled water is prepared to know peak load requirement of chilled water. Similarly time schedule for loading and unloading of the cold storages are also prepared to know peak load requirement of cold storages and accordingly refrigeration plant is operated to conserve energy.

14.4 Electricity Requirement

Electricity requirement for different equipments, pumps, motors, refrigeration plants, lighting and general purpose is calculated based on actual operating load. Depending on the requirement of single phase and three phase connections load distribution is made using necessary controls. All the equipments are provided with safety devices to protect from over load condition or voltage fluctuations. Motors are provided with variable frequency drives and soft starters to conserve energy. Refrigeration plant of dairy contributes approx. 40 to 50% of total electricity load.

14.5 Water Requirement

Water supply for dairy plant is important and must be considered at the planning stage. An adequate supply of pure water for washing of equipment and cooling purpose is essential. An ideal water supply is one that is soft cold and free from all impurities. The water is treated to meet plant requirement by using suitable process. The hardness of the water used in the dairy plant should be maintained below 35 ppm. Generally the ratio of milk: water of fluid milk plant is 1:1, while that of multi product plant is 1:1.5 or 1:2. It depends on type of products made and size of the plant. There are different types of water soft water, well water, chilled water, hot water etc. they are used in the different processes, for cleaning of equipment and floors. The distribution of water can be done by gravity, centrifugal pumps or by hydro flow systems. Hydro flow system is used to have uniform pressure in the water pipe lines, which facilitates operation of automatic control systems. Control of use water is

required to conserve water and to reduce load on effluent treatment plant.

Table: 14.1 Typical Utility and Service Requirements:

UTILITY	DEMAND REQUIREMENTS	SPECIFIC PROCESS
Cold Water:		
10°C City	Rinsing, Washing.	All
1-7°C Chilled	Recirculation Cooling,	All
	Product Cooling	
Hot Water:		
90°C	Pasteurizer Heating	All
70°C	Mould Release	Ice Cream
50 + °C	Washup/CIP	All
Steam:		
Approx 790 kPa abs	Pasteurizer Heating	All
	(usually via Hot Water)	
	Dryer Air Heating	Dried Product
	Evaporation	Evap/Dried Prod
Lower 790 kPa abs	Water Heating	All
Thermal:		
Furnace	Space Heating	All
Boiler	Hot Water/Space Heating	All
Heater	Dryer Air Heating	Dried Product
Refrigeration:		
-40°C	Mould Brine	Ice Cream
-30°C	Freezer/Storage	Ice Cream
-9°C	Ice Cream Maker	Ice Cream
-6°C	Glycol for HTST Chilling	All
1°C	Product Holding Cooler	All
4°C	Milk/Product Cooling	All
Compressed Air	Valve Actuation, Air Blows, Conveying	All
Electrical (Direct Uses)	Conveyor, Centrifuge, Homogenizer, Packaging Unit Drives, Lights, Refrigeration	All

Table: 14.2 APPROXIMATE ENERGY CONSUMPTION IN DIFFERENT MILK PROCESSING OPERATION:

Process	Energy Consumption				
	Heat(steam)			Electrical	Total
	Pressure Kg/sq.cm	Kg steam/lit. milk	Kcal/100 lit. milk	Kcal/100 lit. milk	Kcal/100 lit. milk
Can Washing	-	-	-	-	-
Rotary	3.25	0.51 kg/can	263 kcal/can	13 kcal/can	276 kcal/can
Straight through	4.2	0.43 kg/can	221 kcal/can	13 kcal/can	234 kcal/can
Pasteurization(90% efficiency)	3.0	0.012	750	103	853
Separation	-	-	-	120	120
Homogenization	-	-	-	600	600
Sterilization	-	-	-	-	-
Batch	1.5	0.4	21300	-	21300
Hydrostatic	1.5	0.12	6600	-	6600
Ghee making	-	-	-	-	-
From butter	3.25	0.021	1082	-	1082
From cream	4.3	0.036	1845	-	1845
Powder making (Spacing process)	14.0	-	23000	1790	24790
Bottle washing	3.5	1.3 Kg steam/100 bottle	668 Kcal/100 bottle	95 Kcal/100 bottle	763 Kcal/100 bottle
Bottle filling	-	-	-	52 Kcal/100 bottle	52 Kcal/100 bottle

Table: 14.3 Unit utility requirement approximately for a chilling centre:

Utility	Requirements			Total	3 % loss	G Total (For peak load)
~	Milk processing	Can washing OR Chilling	Other	~	~	~
STEAM (kg/hr)	273.703	215	5	493.703	14.81109	508.51409
Electricity (kwh)	52	80	50	182	5.46	187.46
Refrigeration (TR)	49.26	191.95	5	246.21	7.3863	253.5963
Water (Lit/lit milk)	0.5	1.0	0.25	1.75	0.0525	1.8025

Note- Above data are based on fixed assumptions. If the problem occurs and situation changes than the data may deviate accordingly.