CHAPTER IV

FACTORs AFFECTING PROFITABILITY-2

- PRODUCTION PROCESS

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Introduction

The dairy industry embraces the production of milk and its preparations for sale. The preparation of quality milk for sale and the efficiency of the manufacturing processes adopted for the manufacture of dairy products has great implications on the profitability of the DDCs.

In our country milk is produced under the most unhygienic condition, as such its maintenance of quality is not satisfactory. It goes bad within a few hours of its production, especially in summer. Further, milk is very much contaminated even with pathogenic bacteria, which on consumption as such germinate deadly diseases among the consumers. To avoid such risks milk is subjected to suitable treatment which not only makes the milk safe for human consumption but also enhances its life.

Processing of milk also forms an integral part of the process involved in the manufacture of almost all types of milk products. An efficient system of utilising the dairy plant ensures rapid utilisation of the procured raw milk into milk and milk products. The utilisation of plant to its fullest extent to maximise output along with proper maintenance is important to even out the
incurred depreciations and other overheads on plant and machinery to ensure economic viability. The manufacturing of any milk product has first to undergo the process of pasteurisation.

**Pasteurisation**

Pasteurisation is one of the systems of treatment of milk adopted to render the milk safe for human consumption and to increase its keeping quality. The process is widely employed in all the branches of the dairy industry.

According to the definition of pasteurisation as prescribed under the Prevention of Food Adulteration Rules No. A 11.01.02, 'Pasteurisation', Pasteurised and similar terms shall be taken to refer to the process of heating every particle of milk or milk product to at least 65°C, and holding at such temperature continuously for at least 30 minutes, or heating it to at least 71.5°C and holding at such temperature continuously for at least 15 seconds or on approved temperature-time-combination that will serve to give a negative phosphate test.

All pasteurised milk and milk products shall be cooled immediately to a temperature of 10°C or less, and shall be maintained thereat until delivery.
The term milk product, in context to A.11.01.02, means standardised milk, recombined milk, toned milk, double toned milk, skimmed milk and flavoured milk.

Two general methods of pasteurisation are in use: one is known as the "holding" system and the other as the "high-temperature, short-time", system.

The holding system consists of bringing the milk or cream to a suitable temperature, usually 143°F (61.7°C) or higher and holding it at that point for at least 30 minutes followed by rapid cooling. A higher temperature is sometimes used in dairy manufacturing plants, in which case the time of holding may be shortened. A careful control of both temperature and time of heating is important.

Under the "High-temperature short-time system" the machines used are so constructed as to make possible a continuous operation and for this reason they are also called "continuous flow" or "flush" pasteurisers. The system involves raising the temperature of the milk or cream quickly to at least 160°F (71.1°C) and often higher for a few seconds as it passes through the machine.

The flush system is, especially, applicable to the pasteurisation of cream for butter making and temperatures
above 160°F (71.1°C), normally 160°F (82.2°C), are used. Its chief advantage in creamery operation is the rapidity required for equipment necessary to handle a given amount of cream. The high-temperature short-time system is now being used more extensively for the treatment of milk or cream designed for direct consumption than it was a few years ago. Those in use at present employ hot water or electricity as the heating medium, and may be either the electric, the so called "plate", "external-tubular" (surface) or "internal-tubular" types of equipment.

The raw milk collected by the VCMFSs is brought, twice a day, to the dairy plant of the respective DDCs in Gujarat, where quality of milk is checked. The pasteurisation plant of the DDCs serves as a suitable platform where from milk-producers learn how to produce quality milk; and where from a good dividend flows back to the sources of production for accelerating further production and which also makes milk of uniform quality available at a reasonable price to consumers.

In order to economise the pasteurisation process, the plants must be used at their maximum capacity.
Processes and Composition Standards of Liquid Milk

Different types of liquid milk are sold by the DDCs in Gujarat and hence, the processes involved and their composition differ. However, these processes and their composition standards have been prescribed under the Prevention of Food Adulteration Rules.

Sterilisation: Sterilisation of milk means heating it continuously to a temperature of 115°C for 15 minutes or 145°C for 3 seconds, or equivalent approved temperature-time-combination to ensure preservation at room temperature for a period of not less than 15 days from the date of manufacture. Sterilised milk should show absence of albumin by negative turbidity test. Sterilised milk should be sold only in the containers in which it was sterilised.

Flavoured milk: It may contain chocolate, coffee or any other edible flavour, edible food colours, and cane sugar. Flavoured milk requires to be pasteurised or sterilised.

Standardised milk: When cow or buffalo milk or a mixture of both has been standardised to a fat percentage given in Table IV.1 by the abstraction and/or addition of milk fat, or by addition of skimmed milk or by addition of recombined or reconstituted skimmed milk is designated as
standardised milk. It should be pasteurised and should show a negative phosphatase test.

Recombined milk: It means the homogenised product prepared from milk fat, non-fat milk solids, and water. Recombined milk requires to be pasteurised and should show a negative phosphatase test.

TABLE IV.1

Standards of Milk in Gujarat

<table>
<thead>
<tr>
<th>Class of Milk</th>
<th>Designation</th>
<th>Minimum per cent</th>
<th>Milk Fat</th>
<th>Milk SNF</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td></td>
</tr>
<tr>
<td>Buffalo Milk :</td>
<td>Raw, Pasteurised, Boiled, Flavoured and Sterilised</td>
<td>6.0</td>
<td>9.0</td>
<td></td>
</tr>
<tr>
<td>Cow Milk :</td>
<td>Raw, Pasteurised, Boiled, Flavoured and Sterilised</td>
<td>3.5</td>
<td>8.5</td>
<td></td>
</tr>
<tr>
<td>Standardised Milk : (All India)</td>
<td></td>
<td>4.5</td>
<td>8.5</td>
<td></td>
</tr>
<tr>
<td>Recombined Milk :</td>
<td>(All India)</td>
<td>3.0</td>
<td>8.5</td>
<td></td>
</tr>
<tr>
<td>Toned Milk :</td>
<td>3.0</td>
<td>8.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Double Toned Milk : (All India)</td>
<td></td>
<td>1.5</td>
<td>9.0</td>
<td></td>
</tr>
<tr>
<td>Skimmed Milk :</td>
<td>Raw, Pasteurised, Boiled, Flavoured and Sterilised. (All India) Not more than 0.5 percent</td>
<td>8.7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Prepared milk:** It is the milk product prepared by admixture of cow or buffalo milk or both with fresh skimmed milk, or by admixture of cow or buffalo milk or both with non-fat milk solids or milk powder, and water, or by partial abstraction/addition of fat from/to milk. It should be pasteurised and should show a negative phosphatase test. When fat or dry non-fat milk solids are used, it should be ensured that the product remains homogenous and no deposition of solids takes place on standing.

**Double toned milk:** It is the milk product prepared by admixture of cow or buffalo milk or both with fresh skimmed milk, or by admixture of cow or buffalo milk or both with non-fat milk solids and water, or by partial abstraction/addition of fat from/to milk. It should be pasteurised and should show a negative phosphatase test. When fat or dry non-fat milk solids are used it should be ensured that the product remains homogenous and no deposition of solids takes place on standing.

**Skimmed milk:** It is the product prepared from milk from which almost all the milk fat has been removed mechanically.

The NDCs in Gujarat produce and sell various kinds of liquid milk in varying proportion such as standardised milk, whole milk, toned milk, double toned milk, flavoured
Flow Chart of a Market Milk Plant

Weigh scale
Laboratory ..... Dump tank

Filter

Clarifier
Standardizer
Separator

Cooler

Storage tank

HTST

Surge
or storage
tank

Butter
milk
or Dahi
pasteurizer

Choco-
late
milk
pasteur-
izer

Cream
pasteu-
rizer

Cooler

Storage
in Cans

Filling

Reconstituting
device

Water

Skim
milk
powder

HTST

Storage

Cottage
cheese vat

Cream
pasteurizer

Cooler

Storage
in Cans

Filling

Storage

Cooler

Cans
or tank

Skim milk tank
milk and skim milk. With a view to having a visual idea of a dairy plant manufacturing different milk products, the flow chart of market milk plant is presented in Chart IV.1.

Production Process of Major Milk Products

Apart from the processing different types of liquid milks for sale, the DDCs of Gujarat have also been engaged in the manufacture of such milk products as butter, ghee, milk powder, baby food, cheese, casein and other products as detailed in Table IV.2. The manufacturing processes involved in them are discussed at length in the pages to follow.

Butter: Butter is a homogeneous mix of milk fat and butter milk. It contains some quantity of water and salt and colour are generally subsequently added to it. It is a good source of vitamin A and vitamin D and is characterised by its high spreadability not found in any of its synthetic substitutes.

The chief object of manufacturing butter, besides being one way of utilising surplus milk, is to obtain a fat rich product which can be directly consumed. Butter produced in flush season is mostly stored for using it
Commercial butter is generally produced out of cream. When ripened cream is gently agitated, the fat particles aggregate and form granules which on bulking form a coherent plastic mass called "butter". This is the main principle of butter preparation. But, in actual trade practices, the preparation of butter consists of several such sub-processes as (a) standardisation of the acidity of cream; (b) reduction of the quantity of acid; (c) neutralisation of a mixture of sweet and sour cream; (d) pasteurisation and cooling of cream; (e) cooling the cream after pasteurisation; (f) addition of starter; (g) churning; (h) brushing of butter; (i) salting of butter; and (j) weighing and packing of butter. These processes are discussed briefly in the paragraphs that follow:

(a) **Standardisation of the acidity of cream**: For manufacture of butter the acidity of sour cream needs to be standardised, because it helps in (1) control of the flavour of the fresh butter, (2) control of the quantity of the fat lost during churning, (3) the manufacture of butter of desirable texture, (4) control of keeping quality of the butter, and
(5) manufacturing butter of uniform quality. Two types of neutralisers - the soda compounds and the lime compounds are generally used for the purpose. The practice of using neutralisers with high acid cream is well-established and is generally practiced.

(b) Reduction of the quantity of acid: This is an important part of the butter maker's responsibility. The acidity should be reduced sufficiently so that:

(1) the flavour of the fresh butter is satisfactory;
(2) the loss of fat during churning is kept at the minimum;
(3) the butter is not mealy; and
(4) the butter can safely be stored, if necessary, for an extended time without the development of an oily fish or tallowy flavour.

(c) Neutralisation of a mixture of sweet and sour creams: When a considerable quantity of sweet cream is to be mixed with sour cream in the vat it is desirable to neutralise the sour cream first. If this is not done, a sour or vinegary flavour develops and if curdling takes place during pasteurisation, mealy textured butter is obtained.
(d) Pasteurisation and cooling of cream: In this process, generally the 'High-Temperature Short-Time Method' of pasteurisation is used. The pasteurisation of cream helps (1) to kill bacteria, yeasts and molds; (2) to render enzymes inactive; (3) to eliminate feed or weed flavours through the escape of vapours and gas from the cream, (4) to make butter of uniform quality; and (5) to make butter of good keeping quality.

(e) Cooling the cream after pasteurisation: Cooling the cream pasteurised by the flash method consists of either cooling by means of a surface cooler or by means of plate or internal tubular cooler. Subjecting the cream during cooling to excessive pressure should be avoided so as to prevent churning.

(f) Addition of starter: A desirable flavour can be imparted to butter by addition, from three to five per cent by volume, of a high quality starter to the cooled cream during the late afternoon and churning the cream in the next immediate morning. While manufacturing unsalted butter, a large percentage of starter is being used and the cream is to be ripened to an acidity between 0.40 per cent and 0.50 per cent.
If the starter is used correctly, the following benefits are ensured:

i. it imparts a more desirable flavour to the butter,

ii. it prevents the development of certain undesirable types of bacteria in butter, particularly in unsalted or low salted butter,

iii. it makes less pronounced certain undesirable flavours, such as feed, tallowy and neutraliser,

iv. it aids making butter of a more uniform quality.

(g) Churning: Metal churns constructed of aluminium or stainless steel are now being used. Most churns are equipped to operate at from four to nine speeds that vary from one-half revolution per minute to 30. The temperature of the cream should be such that, under normal conditions, the churning will be completed within 40 to 50 minutes, from the time the churner is started until the buttermilk is drained.

The volume of cream with average fat content and of proper temperature, placed in the churn should be such that there will be sufficient agitation of the cream during churning to give a churning period of 40 to 50 minutes.
The churn should be stopped when butter granules are formed of the size of small peas. The butter milk should be drained as quickly as possible after the churning process is completed.

While loss of some quantity of fat during the churning process is inevitable for one or more causes enumerated below, the loss can be kept to the minimum by (1) controlling the fat test of the cream under process; (2) exercising proper care in pasteurising, cooling, holding and churning the cream:

1. How testing or excessively high testing of cream,
2. Diluting the cream with water or with an excessive amount of starter,
3. Improper neutralisation and pasteurisation,
4. Slow cooling and excessive agitation during cooling,
5. Partial churning during pumping,
6. Churning too soon after pasteurisation and cooling especially during summer,
7. Not holding, cooled cream at low enough temperature after pasteurisation,
8. Churning at too high temperature,
9. Warming the cream excessively during churning and
10. Excessive speed and over-loading the churn.
(h) Washing of butter: After draining out the butter milk, the butter is to be washed. Washing helps in removing the majority of butter milk, improving the keeping quality of the butter, and aiding in controlling the composition of the butter. Washing once, if properly done, is sufficient for average high quality butter as additional washings are time-consuming, expensive and unnecessary.

(i) Salting of butter: After washing is over, salt in specific proportion is added to the butter. A salt content of about 2.5 per cent appears quite suitable to most of the consumers. Salting of butter helps seasoning the butter so that it will have higher relish and it aids in preventing the growth of bacteria, yeasts and moulds.

(j) Weighing and packing of butter: After completing the above discussed processes the butter is weighed and packed in various consumer packs. Special butter packing machines are used for this purpose.

Though the Kaira Union, the Mehsana Union, the Sabarkantha Union, the Banaskantha Union, the Baroda Union and the Surat Union manufacture butter in large quantities, it is pooled and marketed under the trade name of 'AMUL' and 'SACAR'.

In order to have a clear view of manufacturing butter, the flow chart of a butter plant is presented in Chart IV.2.
### CHART IV.2

**Flow Chart of a Butter Plant**

<table>
<thead>
<tr>
<th>Laboratory</th>
<th>Sample</th>
<th>Weigh Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dump Vat</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Neutralizing Vat</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pasteurizing Vats</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Churn</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Butter</td>
<td></td>
<td>Butter milk</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boxed Solids</td>
<td>Trolley</td>
<td>Dried Tank for Feed</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Printer</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laboratory</td>
<td>Cold Store</td>
<td>Sample</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The continuous method of manufacturing butter has become popular in the recent years because of its following advantages over the conventional method:

(i) Increased rate of production,
(ii) Labour saving,
(iii) Ease of handling,
(iv) Time saving, and
(v) Improved keeping quality.

The Mehsana Union has a continuous butter manufacturing machine which started operating in the year 1973-74. Even though initial investment would be higher, on overall evaluation of both the systems, the continuous system is found to be more economical. Further, reworking of butter is now possible by continuous butter making machine with the addition of special equipments and its use will enable the DDCs to store large quantities of fat during the flush season.

Ghee: Ghee (Butter oil) is an important milk product consumed substantially by our citizens. Its economic significance to the dairy industry can be realised from the fact that more than 30 per cent of milk produced in India is converted into Ghee.

Ghee means the pure clarified fat derived solely from milk or curd or from deshi (cooking) butter or from cream to which no colouring matter or preservative is added. Besides, it being a product of tradition with an established market, several other factors as stated below favour the inclusion of ghee in the product mix of most of our dairies:

(i) relatively low cost and simple technology for ghee making,
(ii) comparatively longer shelf life of ghee, without refrigeration,
(iii) need to preserve surplus fat and to salvage substandard and returned milks.

Ghee manufacturing involves three distinct operations:

(i) Concentration of milk fat. (ii) Heat clarification of fat-rich product, and (iii) Removal of residue produced during the manufacturing of ghee. The concentration of fat in the form of cream, deshi or creamery butter helps in reducing (a) the load of ghee residue, (b) fat loss in residue, and (c) the amount of water to be evaporated by heat clarification. During the process of the removal of moisture by heat, ghee acquires its characteristic flavour; nonfatty solids are converted to denatured, brown residue, that is separated in the third step by decantation, cloth or pressure filtration or centrifugal clarification.
Currently, ghee is manufactured in a modern dairy not with any process equipment or systems built specifically for ghee, but with an assemblage of equipments already available to the dairy. Typical dairy ghee making outfit consists of (i) cream separator, (ii) butter churn, (iii) steam-jacketed S.S. Kettle, (iv) ghee filtration device such as disc filter or clarifiers, (v) appropriate storage vats and tanks for cream, butter and ghee, and (vi) pumps and pipe lines interconnecting these facilities.

In Gujarat two types of DDCs are involved in ghee making: (a) Unions with fluid milk plants making ghee as one of their selected list of dairy products, and (b) Unions with milk product factories with ghee included in their product mix charged with the responsibility of maintaining the fluid milk supply throughout the year. City milk plants cannot devote their total attention to ghee. Ghee-making to these plants is essentially a by-product that saves the emergencies arising out of a sharp rise in the seasonal surplus, rejected substandard milk during summer and monsoon, and small amount of returns from city supply in different states of spoilage. Pulled production line oriented approach is often missing in some of these set ups. Problems often arise in the form of poor product recovery and keeping quality.
These are largely due to the inability of these plants to allocate limited and over-strained resources to ghee section in competition to other product lines. In these concerns, a positive attitude of management in adopting simple innovations would bring about substantial improvement in product recovery, quality and productivity, which would ensure higher margin of profits.

Dairy plants of the DDCs, established to handle the regional and seasonal surplus, manufacture large quantity of ghee along with powder and butter. These manufacturing practices aim at recovering as much and as many milk solids as feasible economically.

Several innovations aimed at increasing fat concentration and improving heat clarification of ghee can provide overall product improvement, enhanced product recovery, cut-down production time, and benefit of an overall process economy contributing to higher profitability.

Dry milk manufacturing: Dry milk production has become an increasingly important segment of the dairy industry. These include such features as better keeping quality, less storage space, and lower shipping costs which result in attractive economics. In Gujarat milk powder is being manufactured by six unions, the Kaira Union,
Dry milk provides a means of handling the excess milk produced for other dairy products, especially market milk. Non-fat dry milk (skim milk powders) serves the same purpose for milk solids-not-fat that traditionally butter has done for milk fat. The ultimate aim of the industry is to obtain dry products which, if recombined with water, give little or no evidence of detrimental change compared to the original liquid product. Other aims are to have good keeping quality in all respects and a low manufacturing costs.

The manufacturing process of Non-fat-Dry Milk (Skim milk powder) and Dry whole Milk by spray process are described briefly hereafter.

Manufacture of non-fat dry milk (skim milk powder) by spray process: According to the definition and the standards of quality of milk products prescribed under the Prevention of Food Adulteration Rules, 4 skim milk powder means the product obtained from skimmed milk of cow or buffalo or combination thereof by the removal of water. It may contain added calcium, chloride, citric acid and sodium citrate, sodium salts of orthophosphoric acid and polyphosphoric acid (as linear

phosphate with a degree of polymerisation up to 6 units) not exceeding 0.5 per cent by weight of the finished product. Skimmed milk should not contain more than 1.5 per cent milk fat and moisture should not exceed 5.0 per cent. The minimum solubility/solubility index of product should be as follows:

<table>
<thead>
<tr>
<th></th>
<th>Roller dried</th>
<th>Spray dried</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solubility per cent by weight (minimum)</td>
<td>85.0</td>
<td>98.5</td>
</tr>
<tr>
<td>Solubility index (maximum)</td>
<td>15.0 ml.</td>
<td>2.0 ml.</td>
</tr>
</tbody>
</table>

The process of drying should be mentioned on the label.

The manufacturing of non-fat dry milk consists of several such sub-processes as (a) separation of the cream; (b) pre-heating of non-fat-dry milk; (c) evaporation; (d) spray drying; and (e) dry product removal, cooling and sifting. These processes are discussed briefly in the paragraphs that follow:

(a) Separation of the cream: Separation of cream can be done with or without preheating the milk.

Special cold milk separators are required for the low temperature method. Because fat separation of pre-heated milk is usually slightly more efficient,
suggested temperature is of the range of 60° to 90°F if processing follows immediately. Otherwise, if a holding period is involved, cold milk separation is more practical.\textsuperscript{5} The most important consideration regardless of method is a high degree of separation efficiency. Not more than 0.05 per cent fat (Bob cock method) should remain in skim milk.

(b) Pre-heating of Low-heat non-fat dry milk: Low-heat non-fat dry milk manufacturing requires that heating be carefully controlled to effect the minimum amount of heat induced changes without losing the accomplishment of proper pasteurisation. The control of both time and temperature assumes much significance.

(c) Evaporation: Pasteurised skim milk is condensed continuously in an evaporator (or vacuum pan) to 40 per cent to 48 per cent total solids. Once the desired total solids are obtained in starting the operation, the condensed skim milk is pumped continuously from the evaporator to a small balance tank from where the condensed skim milk is

\textsuperscript{5} B-33 : p.24.
pumped through a pre-heater to raise the temperature to 143°F to 155°F.

(d) Spray drying: The high pressure pump, usually of the piston type, forces the hot product through the spray nozzle into mist-like droplets in the drying chamber. The pressure of the pump ranges from about 1000 to 5000 p.s.i. (pounds per sq. inch) depending on manifold conditions such as nozzle, design and size, inlet and outlet air temperature, drying chamber characteristics, particle size, and moisture content desired.

Inlet air is heated by direct flame or steam coils to 250°F to 500°F. Drying chamber design and subsequent equipment, as well as climatic conditions and desired moisture in the dry product, influence the inlet and exit air temperatures. The exhaust air temperature is the direct guide in controlling moisture of the product. But changes are achieved through adjustment of the inlet air temperature. Low-heat nonfat milk is dried to 3.0 to 4.0 per cent moisture.

(e) Dry product removal, cooling and sifting: Most milk driers have a continuous removal system to immediately separate the dry product from the hot
air stream which has been reduced to the range of approximately 175° to 210°F. The dry product should be cooled at once to approximately 90° to 110°F. Non-fat dry milk packaged too hot may become lumpy due to "heat-aging" and the development of off-flavour and off-colour during storage is much more rapid.

The Kaira, the Mehsana, the Sabarkantha and the Banaskantha Unions manufacture skim milk powder through this process.

Manufacture of dry whole milk by spray process: The manufacture of dry whole milk does not much differ from that of the non-fat dry milk. Since keeping quality is a restricting factor, care should be taken to obtain the maximum storage life. The processes involved in the manufacture of dry whole milk are discussed briefly in the paragraphs to follow.

(a) Standardisation of milk fat: In the first stage, the milk fat is standardised in the ratio of the solids-not-fat so that the dry product will meet the standard of not less than 26 per cent fat. This requires a fat content of 3.2 per cent assuming the solids-not-fat is 6.86 per cent. Some milk is standardised to have 28 per cent fat in the dry form.
(b) Homogenisation of the whole milk. It is common if direct reconstitution of the dry whole milk is contemplated. Without homogenisation the fat may churn during agitation while combining with water. Another advantage of homogenisation is the improvement of keeping quality. The fat globules, although smaller, are more thoroughly covered with the protein membrane. A pressure of 2500 to 3500 p.s.i. at 145° to 165°F, provides sufficient homogenisation.

(c) Pre-heating and evaporation of whole milk:
Numerous optimum temperature-time conditions are being used in pre-heating whole milk. Commercial practice frequently employs the range of 180°F for 15 minutes to 200°F for 3 minutes. When sufficient solids concentration has been attained (35 to 40 %) product is continuously removed from the evaporator.

(d) Spray drying: The temperature of condensed milk after it is pumped from the evaporator is boosted to 145°F to 165°F in a heat exchanger prior to its movement to the high pressure pump. The condensed milk is dried with inlet air at 300°F to 450°F and exit air at 165°F to 200°F depending

upon drier characteristics. To reduce heat damage during the dehydration, without losing the desired moisture, a low exhaust air temperature is preferred.

Dry product removal, cooling and shifting: The dry whole milk should be immediately removed from the hot air stream to maintain better body characteristics and keeping quality. The higher the temperature and the longer the time kept the product is kept above the melting point of the fat, the greater the amount of free fat that results. The use of refrigerated air to move the dry whole milk to a cyclone after it leaves the drying chamber is an important system of decreasing the temperature. Cooling to room temperature (not below) is preferred. The product should be packed immediately or held under a vacuum for 7 to 10 days before gas packaging.

The flow chart for manufacture of spray process non-fat dry milk (skim milk powder) and dry whole milk is presented in Chart IV.3 for precise and quick grasping of the process.

The Kaira and the Mehsana Unions manufacture whole milk powder through this process.
### Flow Chart for Manufacture of Spray Process NFD Milk & Dry Whole Milk

**Receive Milk**
- Cool
- (40°F)

<table>
<thead>
<tr>
<th>Skim milk Powder</th>
<th>Whole milk Powder</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-heat (95°F.)</td>
<td>Standardise fat to SNF 1:2.769</td>
</tr>
<tr>
<td>Separate</td>
<td>Pre-heat (160°F)</td>
</tr>
<tr>
<td>Pasteurise</td>
<td>Filter (or clarify)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>low-heat NDM (161°F for 15 sec)</th>
<th>high-heat NDM (161°F for 15 sec)</th>
<th>Homogenise (3,000 p.s.i)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-heat (185°F for 20 min)</td>
<td>Heat (200°F for 3 min)</td>
<td></td>
</tr>
<tr>
<td>Condense</td>
<td>Condense Pre-heat</td>
<td></td>
</tr>
<tr>
<td>Re-heat (145°F)</td>
<td>Re-heat (165°F)</td>
<td></td>
</tr>
<tr>
<td>Filter</td>
<td>Filter Pump (2,500 p.s.i.)</td>
<td></td>
</tr>
<tr>
<td>Pump (3,000 p.s.i.)</td>
<td>Spray dry (180°F, outlet air)</td>
<td></td>
</tr>
<tr>
<td>Spray dry (185°F, outlet air)</td>
<td>Spray dry (185°F, outlet air)</td>
<td></td>
</tr>
<tr>
<td>Cool (90°F)</td>
<td>Cool (100°F)</td>
<td></td>
</tr>
<tr>
<td>Sift</td>
<td>Sift</td>
<td></td>
</tr>
<tr>
<td>Package</td>
<td>Package</td>
<td></td>
</tr>
<tr>
<td>Store (room temp.)</td>
<td>Store (room temp.)</td>
<td></td>
</tr>
</tbody>
</table>

* packages B-336 p.23.
Infant milk food manufacturing: As per the definitions and the standards of quality of milk products laid down under the Prevention of Food Adulteration Rules A.11.02.  

16. 'Infant milk food' means the product obtained by drying cow or buffalo milk or a combination of both or by drying standardised milk, with the addition of specific carbohydrates (cane sugar, dextrose and dextrins, maltose or lactose), iron salts and vitamins. It should be free from starch and antioxidants. It should be of the specifications as shown below:

<table>
<thead>
<tr>
<th>Item</th>
<th>Standard prescribed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture content</td>
<td>&gt; 5.0 %</td>
</tr>
<tr>
<td>Milk content</td>
<td>&lt; 18.0 % and</td>
</tr>
<tr>
<td></td>
<td>&gt; 28.0 %</td>
</tr>
<tr>
<td>Carbohydrates</td>
<td>&lt; 75.0 %</td>
</tr>
<tr>
<td>Milk protein</td>
<td>&lt; 20.0 %</td>
</tr>
<tr>
<td>Total ash</td>
<td>&gt; 8.5 %</td>
</tr>
<tr>
<td>Ash insoluble in dilute hydrochloric acid</td>
<td>&gt; 0.01 %</td>
</tr>
<tr>
<td>Iron (as Fe)</td>
<td>&lt; 4.0 %</td>
</tr>
<tr>
<td>Vitamin A</td>
<td>&lt; 15 iv/g</td>
</tr>
<tr>
<td>Standard Plate Count</td>
<td>&gt; 50,000 per g.</td>
</tr>
<tr>
<td>Solubility per cent by weight</td>
<td>&lt; 85.0 (Roller dried)</td>
</tr>
<tr>
<td>or</td>
<td>&lt; 98.5 (Spray dried)</td>
</tr>
<tr>
<td>Solubility index</td>
<td>&gt; 15.0 ml. (Roller dried)</td>
</tr>
<tr>
<td></td>
<td>&gt; 2.0 ml. (Spray dried)</td>
</tr>
</tbody>
</table>

The product should be packed in hermetically sealed containers and the label should bear the date by which the product is to be consumed.

A variety of dried milk products are prepared by the total removal of water from whole milk, skimmed milk, butter milk and whey. Malted milk is prepared from whole milk and barely malt. Milk powder suitable as infant food is prepared by spray drying, while other products are manufactured by roller drying. Roller dried products are not as easily dispersed in water as spray dried products but are equally nutritious.

Malted milk is used widely as an infant and invalid food. Malted barely is smashed along with wheat flour in warm water until the starch is converted to maltose and dextrin. The filtered extract is mixed with whole milk and small quantities of common salt and sodium bicarbonate are added. The mixture is then concentrated in vacuum and the concentrate is dried in a drum of spray drier.

The major operations involved in the manufacture of baby food powder by spray drying method are presented in Chart IV.4 to serve as ready reference.

The Kaira and the Mehsana Unions are manufacturing baby food on large scale in Gujarat through this process.
CHART IV. 49

Flow Chart for Manufacture of Baby Food
Powder by Spray Drying Method

Raw Milk

<table>
<thead>
<tr>
<th>Process</th>
<th>Temperature/Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pasteurisation</td>
<td>170°F for 15 sec.</td>
</tr>
<tr>
<td>Standardisation</td>
<td>5 to 3.1% fat &amp; 10%</td>
</tr>
<tr>
<td></td>
<td>SNF or Fat/SNF 0.30</td>
</tr>
<tr>
<td></td>
<td>to 0.31</td>
</tr>
<tr>
<td>Addition of Sugar</td>
<td></td>
</tr>
<tr>
<td>Pre-heating</td>
<td>180°F for 5 minutes</td>
</tr>
<tr>
<td>Condensing</td>
<td>45% T.S. at 27&quot;</td>
</tr>
<tr>
<td></td>
<td>vacuum and 120 to 125°</td>
</tr>
<tr>
<td>Homogenisation</td>
<td>1st stage 2000 lbs/°²</td>
</tr>
<tr>
<td></td>
<td>2nd stage 5000 lbs/°²</td>
</tr>
<tr>
<td>Cooling to 45°F</td>
<td></td>
</tr>
</tbody>
</table>

Addition of disodium phosphate or sodium citrate for reducing the curd tension

Spray drying

Mixing of Vitamins
(may also be added after standardization of milk)

Filling and sealing

Gas packing

Store at room temperature

Cheese manufacturing: Cheese (hard) is defined under the Prevention of Food Adulteration Rules A.11.02.07\textsuperscript{10}, as the product obtained by draining after coagulation of milk with a harmless milk coagulating agent under the influence of harmless bacterial cultures. It should not contain any ingredient not found in milk except coagulating agent, sodium chloride, calcium chloride (enhydrous salt) not exceeding 0.02 per cent by weight, annatto or carotene colour, and should contain emulsifiers and/or stabilisers, namely, citric acid, sodium citrate or sodium salts of orthophosphoric acid and polyphosphoric acid not exceeding 0.2 per cent by weight. Wax used for covering the outer surface should not contain anything harmful to health. In case the wax is coloured, only permitted food colours should be used. Hard cheese should contain not more than 43.0 per cent moisture and not less than 42.0 per cent milk fat of the dry matter. Hard cheese should contain 0.1 per cent of sorbic acid (or its sodium, potassium or calcium salts calculated as sorbic acid), or 0.1 per cent of nisin.

As different varieties of cheese are manufactured, the manufacturing process involved in the preparation of cottage cheese is described here as an illustration.

\textsuperscript{10} B-20 : p.23.
Cottage cheese: Cottage cheese is usually made from skim milk. It may be made from reconstituted concentrated skim milk or non-fat dry milk. There are two factory methods used in making of cottage cheese. In the first method, the milk is coagulated by acidity developed by the action of lactic starter. In the second method, coagulation is accomplished by the combined actions of lactic starter and a small quantity of rennet.

The major steps involved in manufacture of cottage cheese are as under:

(1) Pasteurising high quality skim milk at 145°F to 145°F, for 30 minutes or 161°F for 16 seconds.

(2) Carefully adjusting the milk temperature to 85°F to 95°F in case of short-setting and 72°F in case of long-setting method.

(3) Adding 4 to 5 per cent (in short setting) or 0.3 to 1 per cent (in long setting) of fresh active starter. (For this purpose a mixed lactic starter culture containing lactic streptococci and the associated mesococci species are used).

(4) Adding rennet (in case of lactic acid, rennet cheese) at the rate of 1 ml. for each 1,000 pounds of milk, diluted 40 times its volume in pure water.
(5) Covering the vat, preferably with a metal cover and leaving it undisturbed until the milk is coagulated.

(6) Cutting the curd at a whey-acidity of 0.50 to 0.55 per cent. This may be about 4.5 to 5 hours (short setting) or 12 to 14 hours (long setting) after the starter is added. Curd knives used are usually 1/4 or 3/8 of an inch in size.

(7) Fifteen minutes after cutting the curd, gradually raising up the temperature to 110°F to 125°F fifteen minutes after cutting the curd, which will generally require from 45 minutes to 1 1/2 hours (short setting) or 2 to 2 1/2 hours (long setting) to reach this temperature. The temperature of whey is increased at the rate of 5 to 7°F during 15 minutes interval until the desired cooking temperature has been reached stirring operation should be done with utmost care.

(8) Draining the whey until the top of the curd begins to show (when the curd particles have desired firmness).
(9) Washing of the curd twice or thrice the first washing with cold water at 70°F (slow stirring for 10 minutes), the second, washing with water at 50-55°F (10-15 minutes stirring), and the third washing with water at 40°F (usually not done).

(10) Removing water from the curd, covering the vat of curd and allowing the curd to drain thoroughly.

(11) If salting is desired, it is done in two applications, using not more than 1 per cent of the salt of the weight of the curd.

(12) Holding the salted or unsalted curd at the temperature of 35°F.

(13) Creaming the cheese if so desired by using 14 per cent fat cream so that fat content is not less than 4 per cent.

Amongst the DDCs in Gujarat, the Kaira Union manufacture cheese of different varieties on commercial basis.

Handling Losses in Dairy Operations

Handling losses in dairy operations emerge on account of a large number of factors and their combinations. Seasonal variations have great impact on them.
A vigilant dairy plant operation, therefore, should ensure systematic checking of the flow of milk solids from process to process and from section to section. Most of our dairy plants, in operation, however, do not have adequate facilities for measuring or weighing milk. While passing through from one operation to the other, quantity accounts in proper forms should be maintained to fix the specific responsibility for abnormal handling losses. The management should work out appropriate checks and counter checks to ensure control on them and improve the handling of milk and its products at every stage of manufacturing.

The major losses of fat occur in the manufacture of ghee while solid-not-fat accounts for serious loss in the manufacture of milk powder.

In a study to estimate the percentage loss in milk, fat and solid-not-fat handled at NDRI, handling up to 10,000 litres of milk, it was observed as follows:

(i) The average liquid milk loss per day was 0.67 per cent of the total milk handled.

(ii) The fat and SNF losses were 0.792 % of fat handled and 0.725 of SNF handled.
(iii) The percentage loss decreased with increase in handling capacities. On an average, the milk loss reduced by 0.04% of every five hundred kg. increase in milk handling. In the case of fat, it was 0.45% for every 100 kg. increase in fat handled and in SNF it was 0.23% for every 100 kg. of SNF handled. Details regarding the permissible handling losses in various categories in milk plants of the country are given in Table IV.3

<table>
<thead>
<tr>
<th>Size of Plant (installed capacity in thousand litres)</th>
<th>Ownership of a dairy plant</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Public</td>
</tr>
<tr>
<td>Small (&lt; 10)</td>
<td></td>
</tr>
<tr>
<td>Medium (10-50)</td>
<td>0.1-0.2</td>
</tr>
<tr>
<td>Large (750)</td>
<td>1.0-2.0</td>
</tr>
</tbody>
</table>

In any industrial process, reduction in handling losses would mean increase in production to that extent and therefore it is a very important area of control. Effective control over handling losses in dairy plants would have direct impact on quality and efficiency of the production process.

Proper maintenance of plant, machinery and equipment in a dairy plant is essential for (a) running the plant smoothly, (b) ensuring its maximum productive efficiency, and (c) securing the required standards of quality in the products handled. The work of maintaining the dairy plant efficiently and economically can be ensured if proper control and well-thought-out attention is given whilst (a) designing the dairy building to perfectly house the plant, machinery and equipment; (b) preparing proper plant layout; (c) selecting and erecting the equipment for efficient service and ease of handling; and (d) carefully laying out the floors and the waste disposal system for long service. To ensure proper utilisation of the plant, it is essential that there existed the systems of: (a) periodic inspection; (b) planned lubrication programme; (c) periodic instruments and machinery adjustment; (d) prompt replacement of wornout and damaged parts; (e) recording and reporting of service rendered, with periodic review on the site; (f) maintenance of adequate supplies of spares; (g) proper cleaning and sanitisation of the equipment, building and surroundings; and (h) ensuring full servicibility of all utilities.
Dairies must operate continuously throughout the year and most of the plants have two shifts for processing. Condensing and drying operations often function continuously for 20 hours a day in the season. Thus, there should be adequate provision for inspection and servicing during the free period when the plant is not in use.

Every equipment is supplied with a manual describing the essential instructions for its upkeep and efficient service. Workers concerned should be made familiar with these manuals. Rough handling of sanitary fittings and machined parts such as pump motors, homogenizer valves, pistons etc., must be avoided. Dairy plants should exchange information from the manufacturers and develop local replacements of fast-wearing components. Proper size tools supplied with the equipment should be used for dismantling the equipment for inspection and cleaning. Equipment should be cleaned soon after the operation is over and allowed to drain.

Stainless steel is widely used in the fabrication of dairy equipment and utensils. Stainless steel is subjected to corrosion by agencies like acids and chlorine, if proper care is not taken in cleaning and sanitisation.
Steam and refrigeration are extremely important ancillary services in a dairy. Without adequate and timely steam generation and good chilling facilities, work in the dairy plant would come to a standstill and considerable losses would be incurred. Constant vigilance of these services is, therefore, necessary. There is no substitute for good maintenance to obtain efficient service from boiler and refrigeration equipment. All refrigeration systems should be protected against excessive pressures by installing proper pressure relief or blow off valves. Proper lubrication of refrigeration compressors should be carried as per instructions in manuals. Proper and timely lubrication would go a long way in the smooth running of the equipment, as well as minimising expensive replacements. The DDCs with dairy plants have well-organised maintenance departments to ensure smooth, efficient and economical running of their production processes.