Chapter 10

DRYING OF MILK

(Objectives of milk drying, Spray drying, Drum drying)

Objectives of milk drying

- To preserve for long period by reducing moisture content and as well by reducing water activity.
- To reduce the cost and difficulty of packaging, handling, transportation and storage by converting the material into a dry solid, thus reducing its weight and in most cases volume.
- To add value to the commodity and give a new form.

We all know that different types of dryers can be classified on the basis of type of commodities being handled as follows.

- Dryers for solids and pastes, and
- Dryers for liquid materials.

We also know that the drum dryer and the spray dryer are the two common types of dryers used for drying liquid foods. Thus, they are used also for drying of milk.

SPRAY DRYING

The different parts of a spray dryer are shown in Fig. 10.1

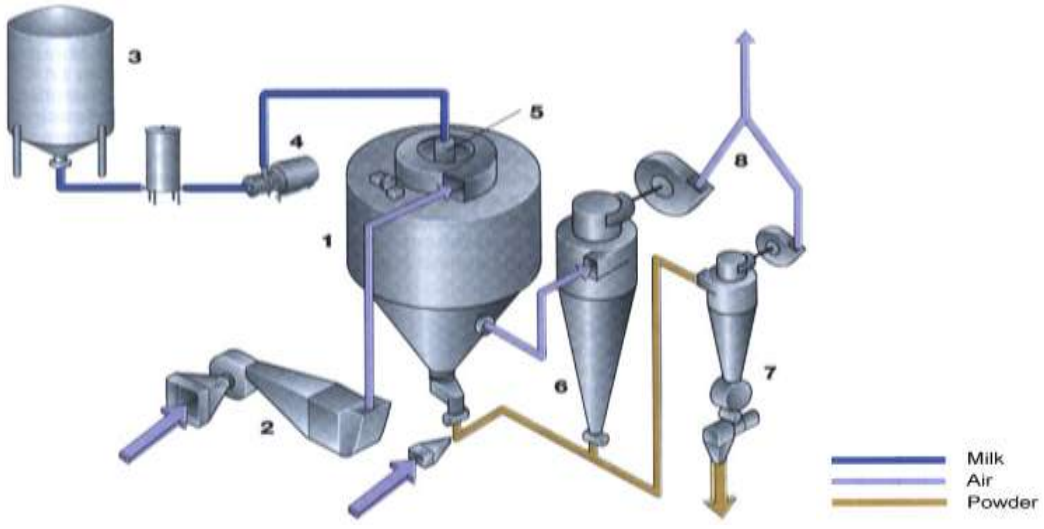

Fig. 10.1 A spray dryer

(1)Drying chamber, (2) Air heater, (3) Milk concentrate tank, (4) High pressure pump, (5) Atomiser, (6) Main cyclone, (7) Transport system cyclone, (8) Air suction fans and filters

The main characteristics of a spray dryer are as follows.

- The liquid food dispersed in to a stream of hot gas
- Rapid vaporization of moisture
- Cylindrical drying chamber with a short conical bottom
- Other major parts: atomization system, air handling system, powder separation system

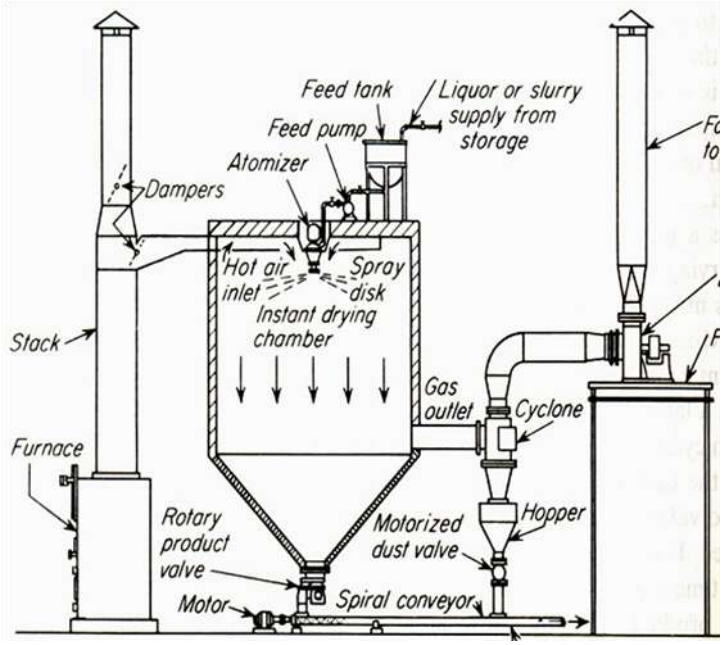

Fig. 10.2 Components of a spray drying system

- Air temperature of 150 to 300°C. Air flow may be concurrent, counter current or a combination of both.
- Dryer chamber: few meters to 25-30 m long, diameters of 2.5-9 m, horizontal/ vertical
- Droplets exit the atomizer at about 50 m/s, but quickly decelerate to terminal velocity (0.2 to 2 m/s).
- Separation of powder is done first by gravitational settling, subsequently by a cyclone separator and then by a textile or bag filter.
- The food is usually fed in a pre-concentrated form to the drying chamber.
- Drying time is usually 5 to 100 seconds.
- The outlet air temperature varies between 50 and 100°C (drying temp-product temp-thermal stability)
- Can be of very high capacity (10000 kg dried milk/h)

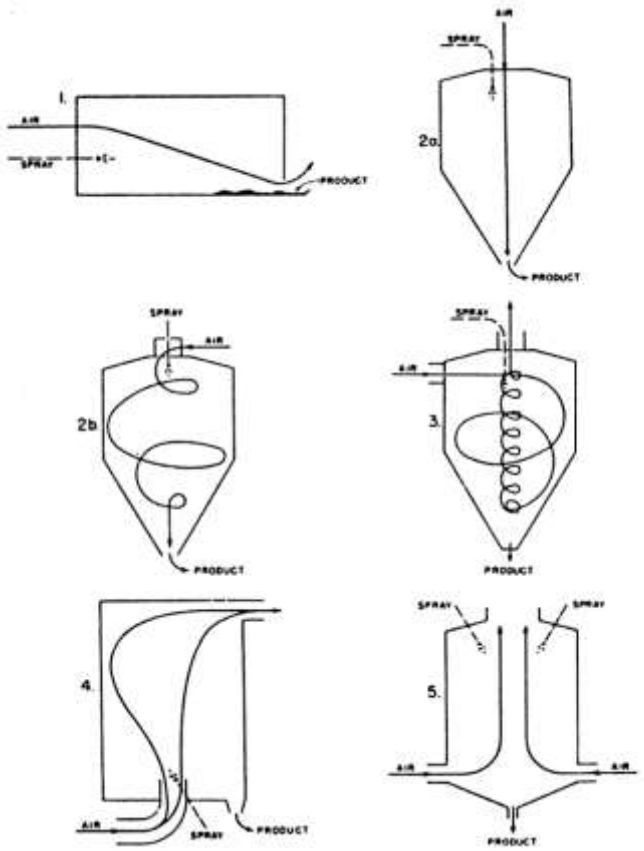

Fig. 10.3 Air and fluid flow patterns in a spray dryer

The atomization is caused by

- High pressure (700 to 2000 kPa) nozzle- It yields the droplets at 100 to 300 μm.
- Centrifugal atomization (disc usually about 300 mm in diameter and rotates at 5000-10000 rev/min, peripheral velocity 90-200 m/s): droplet size is 50-60 μm
- By compressed air.
- Ultrasonic nozzle atomizer (first atomized by a nozzle atomizer and then by using ultrasonic energy to induce further cavitation)

Fig. 10.4 A laboratory spray dryer

Main advantages of spray drying

- Very short drying time
- Large scale continuous production
- Low labor costs
- Relatively simple operation and maintenance.

Disadvantages

- Much heat is lost in discharge gates
- High capital cost (due to atomization)
- Requirement for a relatively high feed moisture content
- Higher volatile losses.

The spray dryers are specifically used for:

Highly heat sensitive materials, e.g. instant coffee and tea, milk powders, soymilk powder, enzymes, cocoa, potato, ice cream mix, butter, cream, yoghurt, cheese, fruit juices, meat and yeast extracts, encapsulated flavors, wheat and corn starch products, egg powders, etc.

DRUM DRYING

It consists of drying of a slurry on a heated drum. The drum dryers can be of many types as shown in Fig. 10.5.

Classification of drum dryers

Number of drums	Feeding device	Pressure or vacuum operation
Single drum	Dip feed	Atmospheric type
Double drum	Splash feed	Vacuum type
Twin drum	Nip feed	
	Roller feed	

Fig. 10.5 Classification of drum dryers

The main characteristics of a drum drying system are as follows.

- Slowly revolving drum(s) 0.6-3 m in diameter, 0.6 to 4 m long. (revolving at 1 to 10 rev/min)
- Steam is supplied to heat the surface of the drum
- Single drum, double drum or twin drum
- Dip feed / spraying / spreading or by auxiliary feed rollers
- Scraper or doctor blade to collect the product
- Drums may be enclosed in a vacuum chamber
- Drying capacity depends on drum area (Usually between 5 and 50 kg/m^2 of drying surface).
- High temperature drying (over 100°C)
- Rapid drying (Residence time 30 to 60 seconds)
- Exposure to high temperatures may cause browning or burnt flavour, protein denaturation
- Because of low thermal conductivity of food, thin layers of food are needed to conduct heat rapidly without causing heat damage.

Fig. 10.6 A laboratory scale double drum dryer

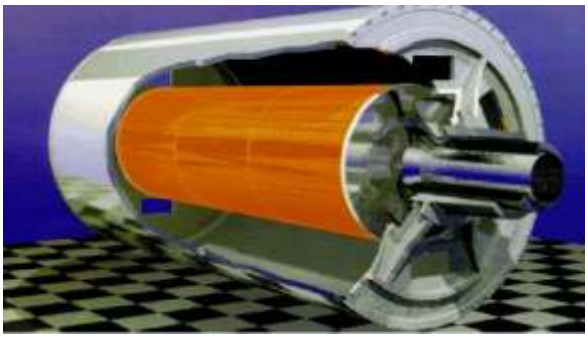

Fig. 10.7 A single drum dryer showing the drum in the drying chamber

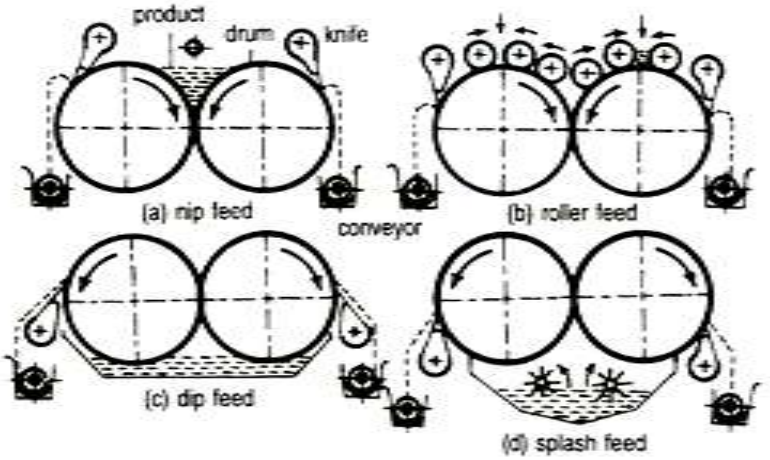

Fig. 10.8 Feeding arrangements in a spray dryer

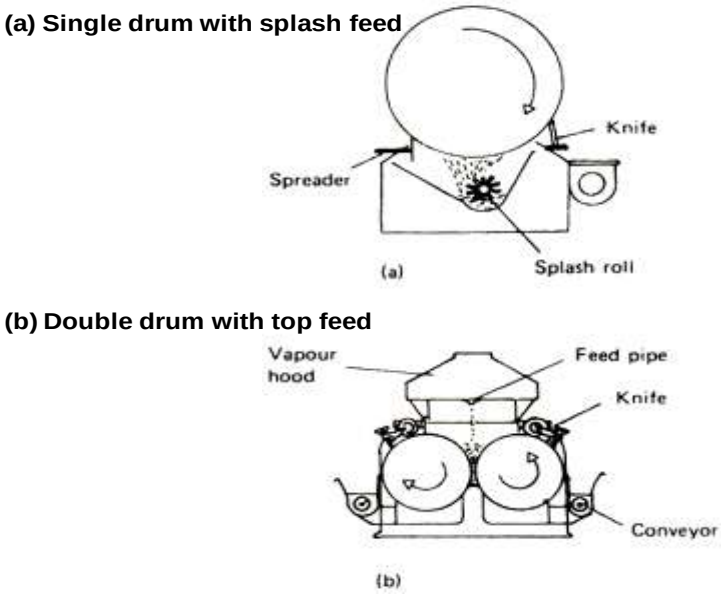

Fig. 10.9 Two common configurations of drum dryers

The drum dryers are also applied to:

- Dilute/concentrated solutions, moderately heavy slurries.
- Not suitable for solutions of salts with limited solubility or for slurries of abrasive solids that settle down and create excessive pressure between drums.
- Earlier used for drying of milk.
- In conduction dryers, typical heat consumption is 2000-3000 kJ/kg of water evaporated compared with 4000-10000 kJ/kg of water evaporated in hot air dryers.

CHECK YOUR PROGRESS

1. Explain the different parts of a spray dryer along with their functions.
2. What are the different powder recovery systems in a spray dryer?
3. What are the different configurations of a drum dryer?
4. Give a comparison between the advantages and disadvantages of spray dryer and drum dryer for milk.