DRYERS



Tray dryer



Tray dryer

Key words:

- rectangular drying chamber
- depth of drying 10-100 mm
- air velocity 0.5-5 m/s
- moist air may make up fresh air
- baffles controlling flow of air to exhaust.
- product is often rotated
- low capital and maintenance cost
- flexibility of drying different types of food
- considerable labour for loading and unloading
- Uniform air circulation
- Contamination by combustion products

Applications:

- Drying of fruits and vegetables,
- foam mat drying, etc.
- For small production rates

Vacuum shelf (TRY) dryer

- Modification of tray dryer
- Hollow shelves in vacuum chambers
- 1-70 Torr is maintained
- Steam or hot water in hollow shelves
- Food as thin layers on flat metal trays on hollow metal plates
- Trays may themselves contain spaces for heating fluid.
- Vacuum pump to remove vapour
- Care to prevent the dried food from burning onto trays
- Shrinkage may reduce heat conduction
- Relatively high capital and operating costs
- Low production rates
- Economics ??

Applications:

- heat sensitive foods
- used mainly for puff drying.

Microwave dryer





Comparison between hot air drying and microwave drying

Laboratory microwave dryer





Industrial Microwave Drying Equipment

Microwave dryer

Key words:

- Microwave radiation causes rapid heating
- In a microwave assisted convective dehydration process, microwaves are used to improve the rate of moisture diffusion from inside of the produce, so as to improve the rate of drying and reduce the drying time.
- More uniform heating, rapid drying without overheating of the product surface, as in other drying processes.

Applications:

• Drying of potato chips, selected fruits and vegetables



Industrial Microwave Belt Type Drying System



Spray drying chamber

Components of a spray drying system







- 5 Atomizer
- 6 Main cyclone
- 7 Transport system cyclone
- 8 Air suction fans and filters













Air and Fluid flow patterns in a spray dryer

Key words:

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

Atomisation by

- High pressure (700 to 2000 kPa) nozzle- 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 50-60 μ m
- By compressed air
- Ultrasonic nozzle atomiser (first atomised by a nozzle atomiser and then by using ultrasonic energy to induce further cavitation)



Key words:

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

Main advantages

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

Disadvantages

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

Applications:

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



Drum drying









Classification of drum dryers

<u>Number of</u> <u>drums</u> Single drum Double drum Twin drum

<u>Feeding</u> <u>device</u> Dip feed Splash feed Nip feed Roller feed <u>Pressure or vacuum</u> <u>operation</u> Atmospheric type Vacuum type

Feeding arrangements in a spray dryer





(b) Double drum with top feed



Key words:

Drum dryer

- Slowly revolving drum(s) 0.6-3 m in diameter, 0.6 to 4 m long. (revolving at 1 to 10 rev/min)
- Steam 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/m² 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.

Drum dryer

Applications:

- 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.

Freezing→ Drying

Dehydrofreezing

Drying → Freezing



Stages of operation in a Freeze dryer







Key words:

- Drying usually in two stages: primary stage: sublimation, secondary stage: vapourisation of unfrozen liquid water
- Rapid freezing: Plate freezer/ air blast freezer /Drum freezer
- Heat supply by combination of conduction and radiation
- Rapid sublimation, but temp below that of melting
- Typical pressure: 1 to 2 Torr
- Condenser
- Excellent product quality & flavour retention
- Cost twice that of vacuum belt drying, and 5 times of spray drying.

Applications:

- High-quality and specialty items e.g. instant coffee, mushroom, etc.
- Active enzyme preparations

Effects on foods due to freeze drying

- Freeze dried foods have a very high retention of sensory and nutritional qualities and a shelf life of longer than 12 months when correctly packaged.
- Aroma retention of 80-100% is possible.
- Texture of the foodstuff is well maintained; there is little shrinkage.
- The open porous structure allows rapid and full rehydration.
- There are only minor changes to proteins, starches or other carbohydrates
- Changes in thiamin and ascorbic acid content during freeze drying are moderate and therefore negligible losses to other vitamins.

Factors responsible for deterioration of freeze dried products

Uptake of oxygen.
Uptake of moisture.
Flavour contamination.
Mechanical damage.
By biological agents.
Exposure to u-v rays.

Thank You