

Module 7 Industrial Freeze dryers

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Freeze drying plants and equipments

In the freeze drying plant, three process sections are especially energy consuming

Process Section I: involves the freezing of the wet product

Process Section II: involves the controlled supply of heat to the product to cover requirements for the sublimation and desorption processes (primary and secondary drying stages)

Process Section III: involves the removal from the freeze drying chamber of the vast volumes of water vapour released during the sublimation and desorption processes.

When evaluating industrial freeze drying plants, the following characteristics are of prime importance:

1. Operation reliability
2. Ease and quality of process control
3. Product losses
4. Vapor trap efficiency

Pilot freeze dryers

- Freeze drying pilot units appropriate for use in the pharmaceutical and food industries, as well as in the laboratory, are in high demand because they are used to explore possibilities for the preservation of labile products, especially with those of biological origin.
- These units are portable and are of convenient size for developmental work on freeze-dried products in laboratories and factories around the world.

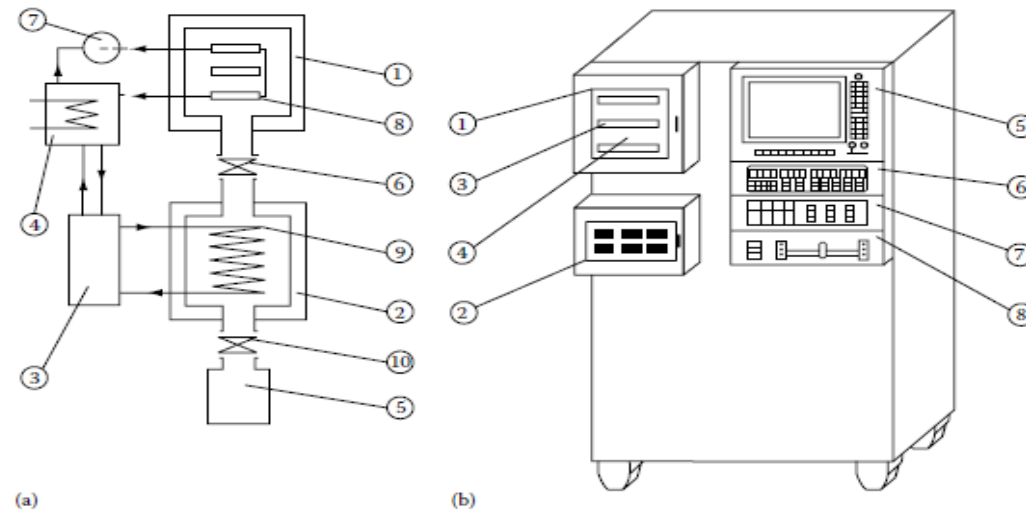


FIGURE 12.3 Pilot freeze dryer: (a) diagram of Criofarma model C5-2; 1, drying chamber; 2, ice condenser chamber; 3, refrigeration unit; 4, cooling and heating system for the plates; 5, vacuum unit; 6, isolation butterfly valve; 7, silicon oil pump; 8, cooling and heating plate; 9, refrigerated coil; 10, condenser vacuum valve; (b) frontal view of model C5-2; 1, drying chamber; 2, ice condenser chamber; 3, cooling and heating plate; 4, inspection window; 5, computer system; 6, vacuum indicator and regulator; 7, temperature control panel; 8, printer. (Model C5-2 courtesy of Criofarma, Torino, Italy.)

The unit consists of

- (a) A freezing fluid system (R13B1) that can be sent to the heat exchanger in the section of the condenser or into the refrigeration coils for product freezing
 - (b) Heating circuit (silicon oil is the heating fluid) for plate heating and defrosting of the condenser and
 - (c) A vacuum system for evacuating air from the apparatus before and during drying.
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- The rectangular drying chamber shown in Figure is mounted on top of the section of the condenser and the dimensions are 0.4 m × 0.4 m with 0.6 m of depth.
 - Viewing windows are incorporated in the sections of drying and condensation.
 - The refrigeration and vacuum systems are in the internal part of the apparatus with complete dimensions of 1.1 m × 0.8 m × 1.8 m (the dimension 1.8 m represents the height of the apparatus).
 - The shelf and ice condenser temperatures of the pilot unit can be -50°C and -70°C , respectively, and the pressure in the drying chamber can be as low as 1 Pa or less.

Industrial Freeze dryers

1. Tray and Pharmaceutical Freeze Dryers (Vacuum batch type)
2. Multibatch Freeze Dryers
3. Tunnel Freeze Dryers
4. Vacuum Spray Freeze Dryers
5. Continuous Freeze Dryers

Vacuum Batch Type

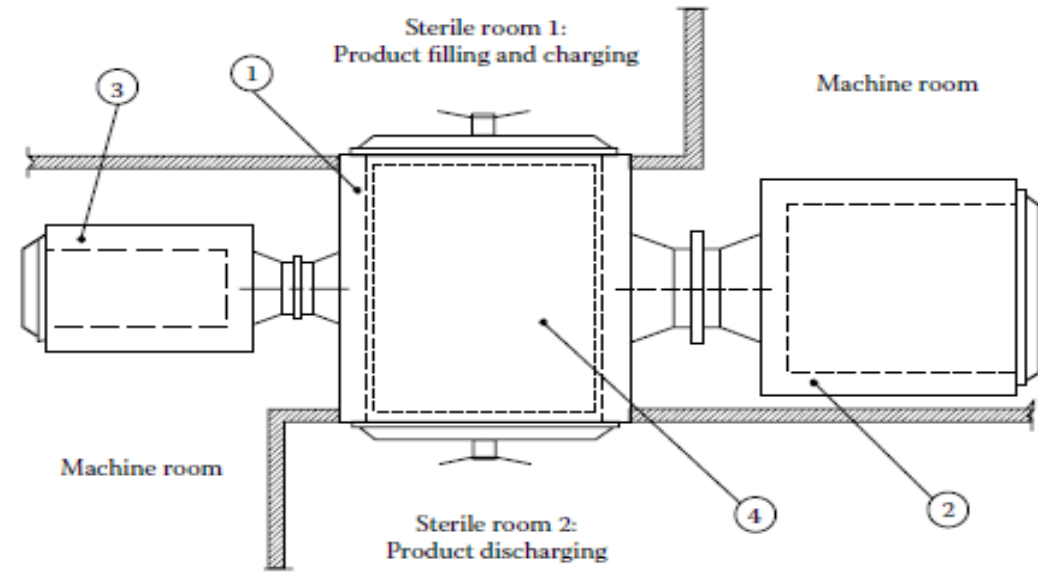
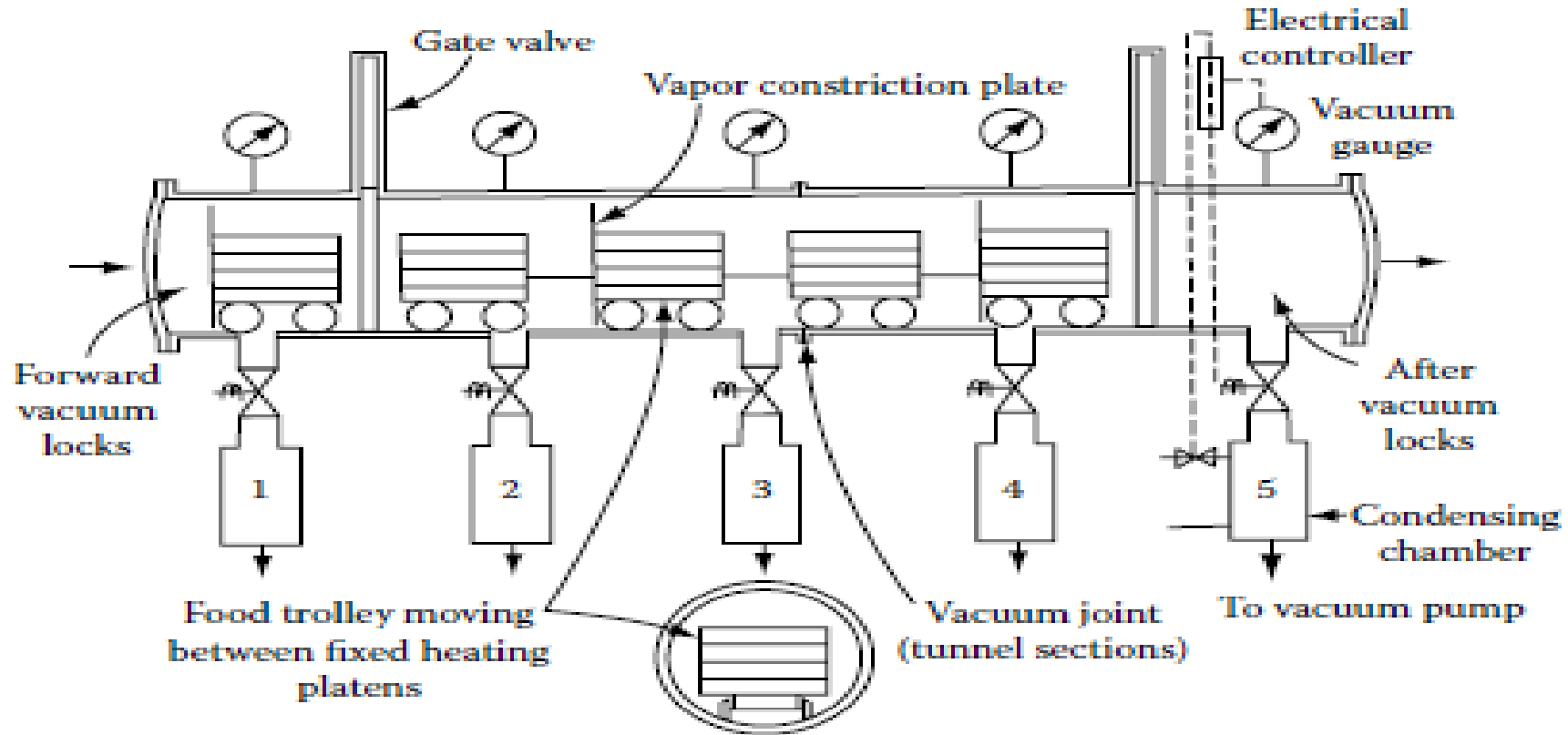


FIGURE 12.5 Top view of an industrial freeze dryer of 60 m² shelf area with auxiliary condenser (Criofarma model C1200-20): 1, drying chamber with double full doors; 2, principal ice condenser chamber; 3, auxiliary ice condenser chamber; 4, product support shelf. (Model C1200-20 courtesy of Criofarma, Torino, Italy.)

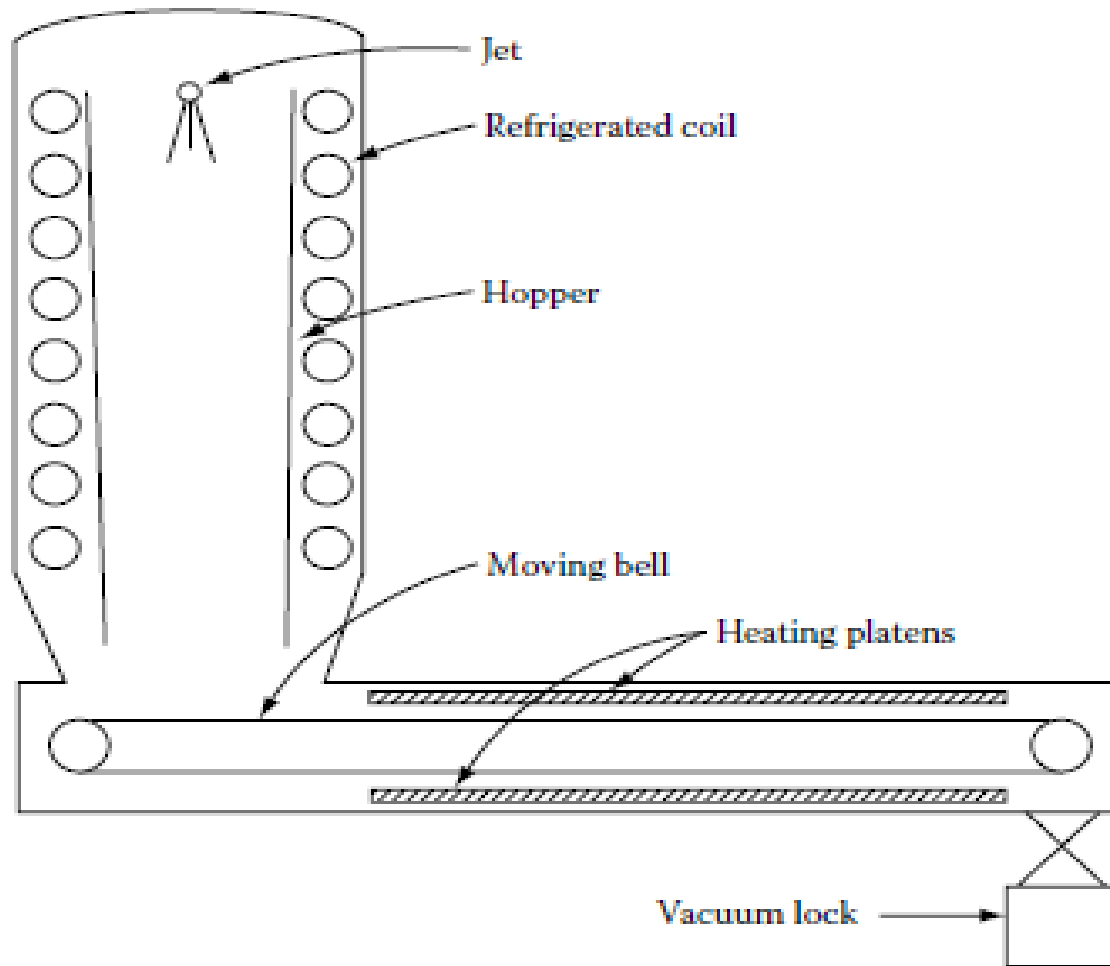
Tunnel Freeze Dryers



In the tunnel type of freeze dryer the process takes place in a large vacuum cabinet into which the tray carrying trolleys are loaded at interval through a large vacuum lock at one end of the tunnel and discharged similarly at the other end.

Fig. Schematic diagram of a typical tunnel freeze dryer

Vacuum Spray Freeze Dryers



- The vacuum-spray freeze dryer has been developed for coffee extract, tea infusion, or milk.
- The product is sprayed from a single jet upward or downward in a cylindrical tower of 3.7 m diameter × 5.5 m high.
- The liquids solidify into small particles by evaporative freezing.
- In the tower a refrigerated helical condenser is coiled between the inside wall and a central hopper, the latter collecting the partially dry powder as it falls freely to the bottom of the tower, which in turn is connected to a tunnel where the drying process is completed on a stainless steel belt traveling between radiant heaters.
- The product passes into a hopper that feeds a vacuum lock, permitting intermittent removal of the product for packing. The whole plant operates under a vacuum of about 67 Pa.
- Frozen particles obtained by spraying into a vacuum are about 150 μm in diameter and lose about 15% moisture in the initial evaporation. There is no sticking of these particles.

Continuous freeze dryers

- Continuous freeze dryers are used for freeze drying of product in trays and for freeze drying of agitated bulk materials. When handling the product in trays, the most delicate treatment of the product is achieved. The product is stationary in the tray and therefore is not exposed to abrasion, and it comes in contact only with surfaces that fully meet standards of hygiene.

Thank you