

3. Drying tests should be conducted in prototype or laboratory units of the most promising equipment available. Sometimes a pilot plant is justified.
4. Summary of tests to evaluate quality and samples of the dried products.

Some items may overshadow the operating cost, or the investment cost, such as:

1. Product quality, which should not be sacrificed.
2. Dusting, solvent or other product losses.
3. Space limitation.
4. Bulk density of product which may affect packaging cost.

A comprehensive bibliography for special reading will be found in the article by S. J. Friedman.⁷

Radiant Drying

In artificial systems, radiating surfaces, heated by steam, electricity or other means, afford a good method of heat distribution and control. Radiant heating sets up convection currents, and in low-temperature dryers

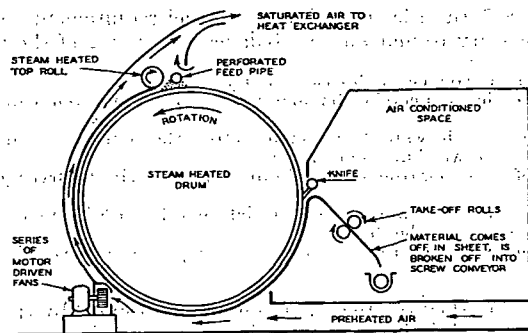


Fig. 6. DRUM DRYER⁵

only about one-third to one-half of the total heat for evaporation is actually supplied to the material by radiation. At high temperatures the radiation output increases rapidly, according to the *fourth-power law*. The total radiation may be computed by the equations and tables given in Chapter 5. In general, fins and irregular surfaces do not increase radiation, hence, the area to be used in calculations is the area of a smooth-surface envelope enclosing the radiating elements.

A certain amount of air circulation is required through a radiant dryer in order to carry off the vapor.

Radiant heat from infra-red lamps has been accepted by certain industries as practicable for their specific problems. An example of successful application is found in the drying of lacquers.

Conduction Drying

Drying rolls or drums, Fig. 6,⁵ flat surfaces, open kettles and immersion heaters are examples of the direct-contact method. Intimate contact of the material with the heating surface is important, and in some cases agitation is desirable to increase the uniformity of heating or to prevent overheating.

A rather interesting method of conduction drying was put into practical

use during the war for the drying of blood plasma, and has since been expanded to other fields such as the preservation of bacteria and other micro-organisms. This has come to be known as freeze drying or drying by sublimation. The material to be dried is first frozen and then placed in a high vacuum chamber connected to extremely low temperature condensers. The water is removed by vaporizing from the solid directly to the gas without ever becoming liquid.

Convection Drying (Direct Dryers)

A typical convection dryer is composed of an air conditioning system, material handling system, and the dryer housing. The normal practice is to recirculate as much as 95 percent of the air, which is desirable from the standpoint of heat economy. There is an optimum point for the percentage of recirculation, depending on the temperature and evaporation rate.

A limited amount of convection drying takes place in almost any dryer such as those described in the preceding paragraphs. However, to be classified as a convection dryer the principal source of heat is the heated air or other gases circulated in the dryer. There are a number of mechan-

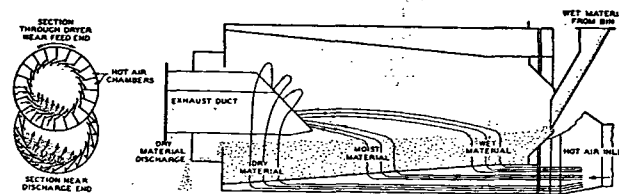


Fig. 7. CROSS SECTION AND LONGITUDINAL SECTION THROUGH CIRCULATION DRYER⁶

ical means of accomplishing this circulation of air or gases, each of which has some particular virtue. Brief descriptions of some important types of convection dryers follow:

Rotary Dryers. These dryers are cylindrical drums which cascade the material being dried through the air stream. (See Fig. 7). The dryers may be heated directly or indirectly, and the air circulation may be parallel or counter-flow. A variation is the rotating louver type dryer, which introduces the air beneath the flights thus securing very intimate contact.

Cabinet and Compartment Dryers. These are generally considered batch dryers wherein each charge is dried to completion before removal.⁸ A wide range includes types from the heated loft with only natural convection, and usually poor and non-uniform drying, to the self-contained units with forced draft and properly designed baffles which give positive results. It is also possible to evacuate some of the systems for low temperature drying of delicate or hygroscopic materials. These dryers are usually loaded with material spread in trays to increase the exposed surface. The trays are loaded directly into the dryer or may be stacked on trucks which are wheeled in. (See Fig. 8)

Tunnel Dryers. Tunnel dryers are a modification of the compartment dryer, and as a rule are continuous or semi-continuous in operation. Heated air or combustion gas is usually circulated by means of fans, although a few natural draft units are still in use. The material is handled on trays or racks on trucks, and moves through the dryer either intermittently or continuously. The air flow may be parallel, counter-flow or a combina-