

air currents or gases. About one-third to one-half of the heat given off by a radiating surface passes through the air to the object which is to be dried, without materially raising the air temperature. The remaining portion of the heat from the radiator warms the air by convection and produces warm air currents which assist in the removal of the moisture. From five to fifteen times as much radiating surface is required for radiant heat as would be needed to heat the same amount of material by heated air currents, so that this method is limited to those operations where the advantages of radiant heat will offset the higher first cost of the equipment.

TYPES OF DRYERS

Film dryers are used for drying thick liquids, pastes and semi-pastes. A thin film of the material is spread over heated cylinders, usually heated by steam and the dry product is scraped off with a knife scraper into a conveyor or receptacle.

Agitator dryers of the *rotary* or *pan* type are used for drying sludges, slimes and fine powders. The material is kept in a continual state of movement or agitation by means of revolving blades or scrapers and by the rotation of the cylindrical container in the case of the rotary dryers. Heat is transferred to the material either directly by contact with steam jacketed casings or rotating steam pipes attached to the agitators or indirectly by passing heated air or gases through the rotary cylinder.

Agitator dryers of the *hearth* or *trough* types as well as the rotary type are used for drying organic waste products. These granular materials are also dried in *vertical* dryers, in which the material drops more or less vertically through currents of heated air either with or without contact with heated surfaces.

Cylinder dryers are used in drying flexible material in long lengths such as textile fabrics of all kinds, paper and fiber board products. Heat is transferred to the material by direct contact with a series of steam heated cylinders.

Vacuum dryers are adapted to liquids, pastes or finely divided granular materials of a delicate nature such as valuable food products which must be dried rapidly at low temperatures in order to preserve flavors and other properties which might be impaired if the drying were done at the higher temperatures necessary with atmospheric pressures. Heat must be supplied to the material either by conduction in contact with a heater container, which is the usual method, or by direct radiation, either from the heated walls or shelves of the container or from the radiating surfaces within the container. The vapor is removed by means of condensers in the vacuum line. Some materials containing only 2 to 3 per cent moisture are first heated before being put in a vacuum chamber. When the vacuum is pulled, the heat vaporizes the moisture and becomes latent, thus cooling the material at the same time.

Spray dryers are used for the drying of thick liquids including any product in solution, suspension, or emulsion. The liquid is first condensed to from 35 to 50 per cent solid content and is then atomized in the form of a fine spray which is distributed in a current of air, heated to a considerably higher temperature than would be used for the same material in a contact dryer. The moisture in the material is vaporized

almost instantly, leaving a dry flour-like powder which falls to the bottom of the dryer. The spraying is done by atomizing nozzles worked either by the pressure of the liquid or by compressed air, or by whirling plates or rotating beaters.

Tumbler dryers are used for drying camp clothing and similar articles. The material is revolved in an open cylinder covered with wire or perforated sheet metal through which a current of heated air is blown:

Air current dryers, of either the *continuous* or *charge* type, are used for drying material in masses of considerable thickness or size and having a close or open texture and a cellular, granular or fibrous structure. The material is placed on trays, trucks or moving conveyors inside of a room-like enclosure and heated by contact with warm air currents which also serve to carry away the evaporated moisture. Drying of this sort is sometimes called "air-processing." The air is warmed, either by direct mixture with furnace gases or by contact with surfaces heated either by direct flame, flue gases, steam or hot water. The source of heat may be either "direct"—located within the dryer, usually in the form of wall coils, floor coils, or distributed coils—or "indirect," the air being heated by radiators outside the dryer and circulated through the dryer by fans and distributing ducts.

Continuous and Intermittent Dryers

Dryers are called *continuous* or *progressive* when a minor portion of the charge is removed and a like portion admitted at more or less regular intervals or in a continuous flow. Continuous dryers are used whenever there is a sufficiently steady production to keep the dryer functioning at approximately full capacity and whenever the duration of the drying period is less than 6 hours or more than 24 hours.

Liquids are adapted to continuous dryers of the film or spray type. Sludges, organic wastes and loose granular materials are dried in continuous dryers of the agitator variety including hearth, rotary, pan and trough types. Flexible materials in long lengths are dried continuously on cylinder dryers, while room dryers of the tunnel type are used for bulky products placed on movable trays, trucks, or endless conveyors. For heavy materials, such as lumber, handled on trucks, the rails in the tunnel are often sloped toward the discharge end in the ratio of from 1 in 60 to 1 in 100 to obtain the benefit of gravity in moving the material.

Continuous tunnel dryers do not lend themselves to exact control of drying conditions for the following reasons: variation in the amount of evaporation from the material, irregularity of charging and discharging and the opening and closing of doors permitting heat to escape and outside air to enter thus effecting the temperatures and humidities in the dryer.

Intermittent or *charge* dryers are charged in one operation and discharged again after the drying is completed. Vacuum dryers and room dryers of the compartment type are the principal kind of dryers operated in this manner. *Compartment* dryers consist of an enclosure in which the material is arranged on trays or trucks or in piles in such a way that currents of heated air pass over the surfaces. The material is usually stationary but is sometimes shifted in position or kept in motion for greater uniformity and speed of drying.