Heated Air Drying

Advantages

- Independent of weather
- Fast drying
- High drying capacity per fan horsepower
- Used for both long- and short-term storage of grains

Disadvantages

- Higher initial investment and maintenance cost
- Considerable fuel expenditure
- Danger of fire hazard
- Requires skilled manpower for control of drying condition
- By direct firing with liquid fuel, products contaminated with flue gases

The fluidized bed and spouted bed drying systems are detailed in Das and Chakraverty (2003).

Radiation Drying

Radiation drying is based on the absorption of radiant energy of the sun and its transformation into heat energy by the grain. Sun drying is an example of radiation drying. Radiation drying can also be accomplished with the acid of special infrared radiation generators, namely, infrared lamps. Moisture movement and evaporation is caused by the difference in temperature and partial pressure of water vapor between grain and surrounding air. The effectiveness of sun drying depends upon temperature and relative humidity of the atmospheric air, speed of the wind, type and condition of the grain, etc.

Sun Drying

Sun drying is the most popular traditional method of drying. A major quantity of grain is still dried by the sun in most of the developing countries.

Advantages

- No fuel or mechanical energy is required
- Operation is very simple
- Viability, germination, baking qualities are fully preserved
- Microbial activity and insect/pest infestation are reduced

- Labor-oriented
- No pollution

Disadvantages

- Completely dependent on weather
- Not possible round the clock or round the year
- Excessive losses occur due to shattering, birds, rodents, etc.
- Requires specially constructed large floor area, restricting the capacity of mill to a certain limit
- The entire process is unhygienic
- Unsuitable for handling of large quantity of grain within a short period of harvest

Infrared Drying

Infrared rays can penetrate into the irradiated body to a certain depth and transform into heat energy. Special infrared lamps, or metallic and ceramic surfaces heated to a specified temperature by an open flame, may be used as generators of infrared radiation.

Advantages

- Small thermal inertia
- Simplicity and safety in operation of lamp radiation dryers

Disadvantages

- High expenditure of electric power
- Low utilization factor

Radiation dryers have been used in many countries for drying the painted surfaces of machinery, and in timber processing, textile industry, and cereal grain and other food industries.

Solar Drying

A solar drying system can be effectively utilized in tropical and subtropical countries where solar energy is abundantly available and solar insolation is also appreciably high. Various designs and capacities of solar dryers with the variation in efficiency are available.

One of the major components of a solar dryer is an absorber that receives and absorbs solar spectrum of radiation. This absorber transforms the radiation energy to thermal energy for heating air flowing over it, which can be utilized as a drying medium. Solar air dryers can be classified into natural convection and forced convection dryers. These can be operated in either direct mode or indirect mode.

Natural convection solar dryers do not require any fan or blower for air circulation in the dryers. Hence, these dryers are cheap and easy to operate. But the drying operation would be slow and take longer drying time. The simple solar cabinet dryers come under this category.

In the category of forced convection solar dryers, blowers circulate adequate quantity of air through the drying material. These dryers cart dry a comparatively large quantity of material with a reduced drying time. Bin type–forced convection solar dryers are quite common.

Integrated Hybrid-Type Solar Grain Dryer

Solar energy is not available round the clock and the year round. Hence, an auxiliary air-heating system is necessary for a continuous drying operation. An improved solar energy storage system may not be economical. In view of these common problems, a solar-cum-husk-fired flue gas grain drying system of 1 ton/day capacity has been patented by Chakraverty, Das, and IIT, Kharagpur, India, for commercial exploitation.

It comprises an inclined roof cum solar flat plate collector for heating air, a husk-fired furnace, and a grain dryer. It is suitable for drying grain for both seed and food purposes.

Its principle, structure, and operations are detailed in Chakraverty et al. (1987).

Dielectric and Microwave Drying

In dielectric drying, heat is generated within the solid by placing it in a fixed high frequency current. In this method, the substance is heated at the expense of the dielectric loss factor. The molecules of the substance, placed in a field of high frequency current, are polarized and begin to oscillate in accordance with the frequency. The oscillations are accompanied by friction and thus, a part of the electrical energy is transformed into heat. The main advantage of this method is that the substance is heated with extraordinary rapidity.

The amount of microwave energy dissipated as heat in a certain volume of material can be expressed by the following equation (Das and Chakraverty, 2003):

$$\left(\frac{P}{V}\right) = 2\pi\gamma \in_1 E_{\text{loc}}^2$$

where

P is the microwave power dissipated as heat, W

V is the volume of material, m^3

γ is the frequency of microwave field, Hz

$\in_1$ is the loss factor of material

E_{loc} is the local electrical field strength within the material, V/m

The dielectric drying has now been in use in different industries such as timber, plastics, and cereal grain processing.

Chemical Drying

Various chemicals such as sodium chloride, calcium propionate, copper sulfate, ferrous sulfate, urea, etc., have been tried for preservation of wet paddy. Of these, common salt has been proved to be effective and convenient for arresting deteriorative changes during storage. When wet paddy is treated with common salt, water is removed from the rice kernel by osmosis. The common salt absorbs moisture from paddy but it cannot penetrate into the endosperm through the husk layer. This is a unique property of the paddy, which has rendered the application of common salt preservation possible.

Advantages

- It not only dries paddy but also reduces the damage due to fungal, microbial, and enzymatic activities and heat of respiration.
- It does not affect the viability of the grain.
- The milling quality of paddy is satisfactory.
- Loss of dry matter is negligible.
- It does not affect the quality of rice bran.

Disadvantages

- The moisture may be retained on the husk due to the presence of sodium chloride.
- The useful life of gunny will be shortened.
- The color of husk changes to dark yellow.
- The common salt–treated paddy requires an additional drying subsequently.
- Economy of the process has yet to be established.

Sack Prying

This method is particularly suitable for drying of small quantities of seed to prevent mixing of varieties and conserve strain purity and viability.

The grain bags are laid flat over holes cut on the floor of a tunnel system so that heated air can be forced up through the grain from an air chamber underneath.

Usually an air temperature of 45°C with an airflow rate of 4 m^3/min at 3–4 cm static pressure per bag of 60 kg is used for fastest drying rate. The sacks are turned once during the drying operation. The sack drying process involves higher labor cost.