



ROHINI

COLLEGE OF ENGINEERING AND TECHNOLOGY

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DEPARTMENT OF AGRICULTURAL ENGINEERING

AI3601 POST- HARVEST TECHNOLOGY

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UNIT II: PSYCHROMETRY AND DRYING

CO2: To perform drying of agricultural products and analyze performance of dryers.

Drying

Drying is the process of removing moisture from agricultural products like grains, fruits, and vegetables to prevent spoilage during storage. It involves controlled exposure to heated or ambient air, allowing safe moisture levels to be reached through principles such as thin-layer or deep-bed drying.

Theory of Drying:

- Theory of Drying explains how moisture is removed from a wet solid (like grain) when exposed to heated air.
- It involves two main stages: **constant rate period** (surface moisture evaporates freely) followed by **falling rate period** (internal moisture moves slowly to the surface), until equilibrium moisture content is reached.

How can we control the drying rate period?

- **During constant rate period:**
 - a) Increase air temperature – Higher temperature speeds up evaporation from the surface.
 - b) Increase air velocity – Faster airflow carries moisture away quickly.
 - c) Reduce air humidity – Use dehumidified or dry air to maintain a strong moisture gradient.
 - d) Spread material thinly – Increases surface area exposed to air.
- **During falling rate period:**
 - a) Control temperature carefully – Too high can cause cracking; too low slows drying.
 - b) Moderate airflow – Avoid excessive airflow that can cause case-hardening (surface dries too fast, trapping moisture inside).
 - c) Step-down drying – Use higher temperature initially, then lower it as moisture moves from inside to surface.

- d) Intermittent drying – Alternate drying with rest periods to allow internal moisture to migrate to the surface.
- e) Monitor moisture content – Use a moisture meter to avoid over-drying.

Principles of Drying:

- **Heat application:** Applying heat to the wet material (like grains) raises its temperature, making moisture easier to evaporate from the surface.
- **Air movement (ventilation):** Moving dry air over the material carries away the evaporated moisture and replaces it with fresh, dry air.
- **Humidity difference (driving force):** Drying happens because the air around the material has lower humidity than the moisture on the material's surface – moisture moves from wetter to drier air.
- **Moisture migration:** Moisture inside the material moves to the surface (through diffusion or capillary action) so it can be evaporated.
- **Two-stage drying process:**
 - a) Constant Rate Period: Water on the surface evaporates quickly at a steady rate.
 - b) Falling Rate Period: Internal moisture moves slowly to the surface, so drying slows down until it stops when the material reaches equilibrium moisture content with the air.
- **Controlled Conditions:** Keeping temperature, airflow, and humidity at the right levels prevents damage (like cracking or mold) and ensures even, efficient drying.

Applications of Drying:

- Grain storage
- Fruits and vegetables preservation
- Seed processing
- Animal feed production
- Biomass and fuel processing
- Tea, coffee & cocoa processing
- Dairy industry
- Fish & meat preservation
- Medicinal & aromatic plants
- Dehydrated & instant food products

Classification of Drying processes:

- a) Based on the heat transfer method,
 - i) Conductive Drying,
 - ii) Convective Drying,
 - iii) Radiative Drying,
 - iv) Microwave Drying
- b) Based on the operation mode,
 - i) Batch Drying,
 - ii) Continuous Drying
- c) Based on the material state / arrangement,
 - i) Thin-layer Drying,
 - ii) Deep-bed Drying,
 - iii) Fluidized bed Drying
- d) Based on the drying medium and technique,
 - i) Hot air drying
 - ii) Freeze drying (Lyophilization)
 - iii) Vacuum drying
 - iv) Superheated steam drying
- e) Based on the scale and application,
 - i) Natural / sun drying
 - ii) Mechanical / artificial drying
 - iii) Hybrid / solar-assisted drying

Disadvantages / Limitations of Open Sun Drying:

- **Unpredictable & slow:** Highly dependent on weather; rain, clouds, or humidity can slow down or spoil the drying process.
- **Poor quality & contamination:** Exposed to dust, dirt, insects, birds, and animals, leading to contamination, discoloration, and loss of quality.
- **Uneven drying:** Sunlight and air exposure are inconsistent, causing some parts to over-dry while others remain moist.
- **High labour & large space needed:** Requires frequent turning, spreading, and gathering of crops, plus large open areas.
- **No Control:** No way to control temperature, humidity, or drying rate, which can lead to mold, fermentation, or nutrient loss.

Factors causing successful Drying:

- ❖ Correct temperature
- ❖ Proper airflow
- ❖ Low humidity of drying air
- ❖ Uniform spread of grains
- ❖ Optimal initial moisture content
- ❖ Correct drying time
- ❖ Proper dryer design and operation
- ❖ Post-drying cooling
- ❖ Regular monitoring
- ❖ Clean & quality raw material