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It’s Important to Know!

BP304T — Pharmaceutical Engineering

B.Pharm Semester 3 · Unit 3 — Drying and mixing

Unit III: Drying and mixing

Drying principles

Drying removes moisture or another volatile liquid by heat and mass transfer. Moisture may be free, capillary-held, adsorbed or bound. Equilibrium moisture content is the moisture remaining when a solid equilibrates with surrounding conditions. A drying curve commonly shows an initial adjustment, constant-rate period and falling-rate period, but the exact curve depends on material and process.

Tray dryers use heated air over trays. Drum dryers form a film on a heated surface. Spray dryers atomise a feed into hot gas and can produce powders rapidly. Fluidised-bed dryers suspend particles in air and provide good contact. Freeze drying removes ice by sublimation under reduced pressure after freezing, helping preserve heat-sensitive materials but requiring long cycles and control of collapse.

Mixing

Mixing aims to reduce concentration differences. Liquid mixing may use impellers that create axial, radial or mixed flow. Semisolid mixing requires torque and suitable blade geometry. Solid mixing involves convection, diffusion and shear, while segregation can occur because of differences in size, density or shape.

Mixing time, order of addition, fill level, speed, viscosity and scale affect uniformity. Overmixing can cause heat, aeration, segregation or particle damage. Equipment-specific selection is set out in the approved specification for a named product.

Unit III: Frequently asked questions

Q: What is equilibrium moisture content?

A: It is the moisture content at which a material is in balance with the surrounding air under specified temperature and humidity.

Q: Why can spray drying produce a powder from a liquid feed?

A: Atomisation creates droplets with high surface area, allowing rapid solvent evaporation in a heated gas stream.

Q: What causes segregation after powder mixing?

A: Differences in particle size, density, shape, flow or vibration can cause components to separate after mixing.

Unit III: Key takeaways

- Drying combines heat transfer with movement of moisture through and from a solid.
- Drying rate depends on material structure and air conditions.
- Spray and fluidised-bed dryers have different particle and residence-time effects.
- Mixing reduces concentration gradients but can also promote segregation.
- Scale-up must preserve the relevant process variables.

Unit III: Practical correlation

Practical correlation: granule drying. Drying should target a moisture range that supports flow and compression without causing degradation or over-drying. The product-specific endpoint and sampling plan are set out in the approved specification.