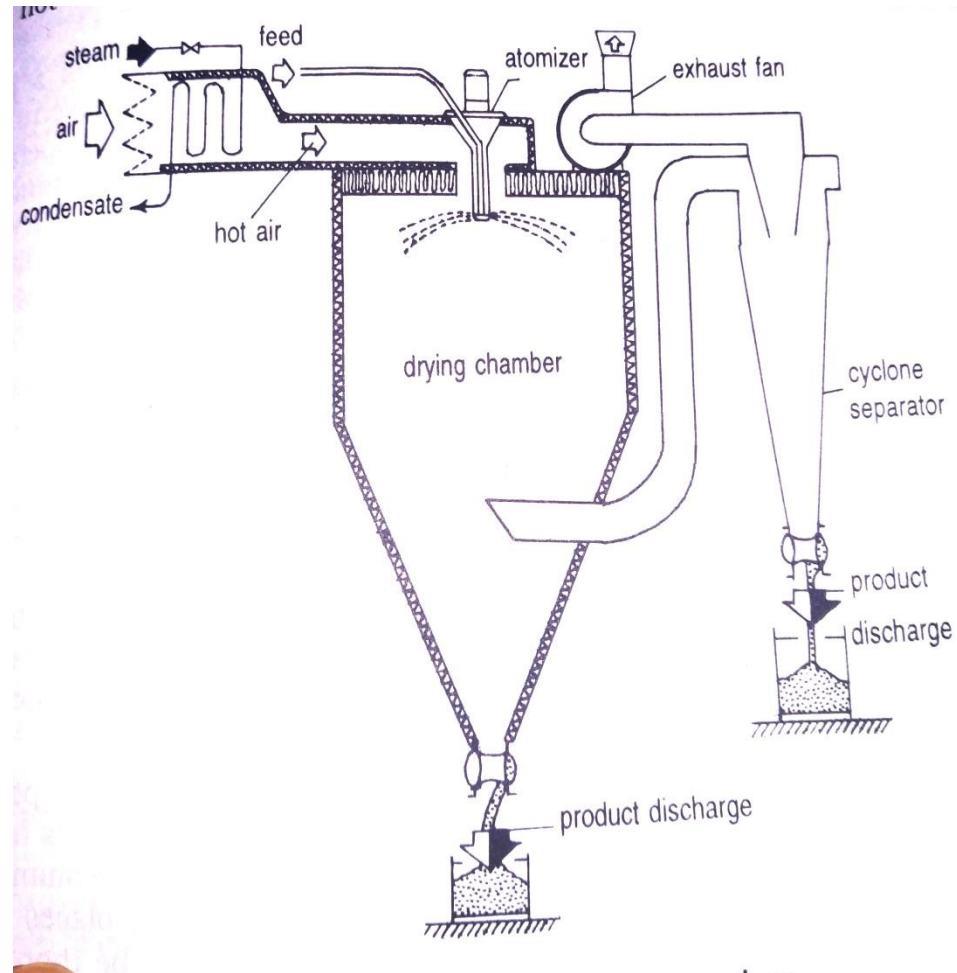


Spray Dryer

- ✓ A spray dryer takes a liquid stream and separates the solute or suspension as a solid and the solvent into a vapor.
- ✓ The solid is usually collected in a drum or cyclone.
- ✓ The liquid input stream is sprayed through a nozzle into a hot vapor stream and vaporized. Solids form as moisture quickly leaves the droplets.
- ✓ A nozzle is usually used to make the droplets as small as possible, maximizing heat transfer and the rate of water vaporization.
- ✓ Droplet sizes can range from 20 to 180 μm depending on the nozzle.
- ✓ There are two main types of nozzles:
 - ✓ High pressure single fluid nozzle (50 to 300 bars) and
 - ✓ Two-fluid nozzles: one fluid is the liquid to dry and the second is compressed gas (generally air at 1 to 7 bars).
- ✓ Spray dryers can dry a product very quickly compared to other methods of drying. They also turn a solution (or slurry) into a dried powder in a single step, which simplifies the process and improves profit margins.

Working of Spray Dryer



Schematic diagram of common spray dryer

Independently of the degree of complexity of the factory, the spray drying process is made of 5 main steps described thereafter.

1. Wet Process
2. Atomization
3. Contact in between the material to be dried and the air
4. Drying
5. Solid separation

1. Wet Process

Prior to spray drying, the materials to be dried are in liquid form. The process prior to the spray dryer aims at conditioning the materials in a way that will make the spray drying possible and will optimize its yield. Typical process steps in this part of the line are the following :

- i. Dissolution / formulation – if the raw material is not available directly in liquid form
- ii. Concentration / evaporation : increasing the total solid will result in a better yield for the spray dryer
- iii. Heating : heating can help to counterbalance the increase of viscosity due to the concentration
- iv. Pumping : the slurry is pumped at high pressure to the spray dryer

2. Atomization

In order to ensure a very fast drying it is necessary to atomize the influx of liquid in very small droplets. This increases a lot the exchange surface where humidity can leave the particles.

This atomization is done thanks to 1 or several nozzles. Different nozzle design exist and must be chosen according to the material and the flowrate in order to give the best results :

- i. Pressure nozzles
- ii. Rotary nozzles
- iii. 2 fluids nozzles

3. Contact in between the material to be dried and the air

- Drying is taking place thanks to dry air contacting the sprayed droplets. The air ability to take up moisture, and thus dry the particles is increased by heating up the air prior it enters the spray drying chamber. It has a low relative humidity at inlet and a high relative humidity, lower temperature at the exit.
- Air can either be blown co-currently to the product, from the top of the tower, or counter-current, from the bottom. In many process application counter-current is preferred but for spray drying co-current has a key interest : the air at the higher temperature contacts 1st the particles with the highest humidity which helps protecting the particles against over heating.

4.Drying

Drying is actually happening all along the spray drying chamber following the progression of the solids particles inside. Moisture is removed step by step thanks to a mass and heat transfer in between the particle and air :

- i. **Constant drying rate** : the particle is saturated in liquid, the mass transfer goes as fast as possible depending especially on the particle surface area
- ii. **Falling rate** : once the particle surface is not anymore saturated in liquid, the drying will depend on the capacity of the liquid trapped in the solid particle matrix to diffuse until the surface in order to evaporate. It is a diffusion controlled process.
- iii. **Bubble formation** : during the falling rate period, the temperature of the particle increases. If it reaches a temperature higher than the boiling point of the liquid, it may vaporize in the particle and expand it creating a bubble.

5. Solids separation

- Once the particles are dried it is necessary to collect them. Very often such a separation is done in cyclones which may be equipped with filters to increase their efficiency.
- The powder is collected at the bottom of the spray dryer and pneumatically conveyed to a cyclone where it is separated with the air. The air in the drying chamber is also sent to another cyclone where fine, which may have been carried over by the air are separated and sent back to the main product stream. Humid air is generally rejected but in some case, as it is still hot, it can be further used for other process operations – pre-heating.

Advantages of Spray Dryers

- Product quality and properties can be effectively controlled and maintained through the entire drying operation.
- Thermolabile products/pharmaceutical can be dried at atmospheric pressure and low temperature.
- Spray dryer permits high- tonnage production in continuous operation adaptable to conventional PLC control (Programmable Logic Controller) and it is relatively simple to operate.
- Feedstock in solution, slurry, emulsion, paste and melt form can be dried if pumpable.
- Corrosion problem is minimal and the selection of materials of construction of spray dryer is simplified since the dried material comes in contact with the equipment surfaces in an anhydrous condition.
- Spray dryer produces dry powder particle of controllable particle size, shape, form, moisture content and other specific properties irrespective of dryer capacity and heat sensitivity.
- Spray dryer handles a wide range of production rate and provides extensive flexibility in its design that is product specification are readily met through the selection of appropriate spray dryer design and its operation from a wide range of available design.
- It is an energy-intensive equipment because;
 - Specific heat of evaporation can be supplied in a short time.
 - The temperature difference across the drying chamber is relatively small and
 - An appreciable amount of heat is lost with exhaust air.

Disadvantages of spray dryers

- Spray dryer is bulky and also expensive to install.
- It is difficult to clean after use.
- It has a low thermal efficiency that is a lot of heat is wasted during operation.
- Solid materials cannot be dried using spray dryers.
- Product degradation or fire hazard may result from product deposit on the drying chamber.

Application of Spray Dryer

- In dairy production and processing of milk.
- Production of Powdered milk, skimmed milk and whole milk.
- Processing Egg-based products .
- Production of sweets and ordinary edible acids.
- Processing Coffee/ Tea whiteners.
- Wheat and corn based products in bakery.
- Spray dryers find application in tablet production for drying of liquid to powder.
- Used in production of dye colour, food colours, paint pigments.
- Soap and detergent manufacturing processes utilise the spray dryers.
- Spray dryer find place in fertilizer production like nitrates, ammonium salts, phosphates and others.
- Spray dryers are very useful in drying of citric acid, borax, sodium phosphate, hexamine, gelatine and extracts.

Thank

you