Muhammad Qamar -Uz- Zaman
Assistant Professor
Department Of Pharmacy
The Islamia University Bahawalpur.

N 3/19

Page: 1—9

Spray Drying

Definition:

Process of microencapsulation in which solid or liquid to be encapsulated is added in a solution of coating material and then atomization and evaporation of solution is carried out. As a result of evaporation of solution coating material gets deposited around the core material and microcapsules or microspheres are formed.

Principle:

Spray drying is a process in which fluid (containing drug to be encapsulated and containing solution) is dispersed as fine droplets into moving stream of hot gases. When liquid come in contact with the hot gases, the fluid evaporates rapidly and dry fine free flowing microcapsules are formed.

Procedure:

Two types of procedures can be adopted depending upon the nature of material to be encapsulated, i.e

1. Procedures adopted for solids

2. Procedures adopted for oily liquids.

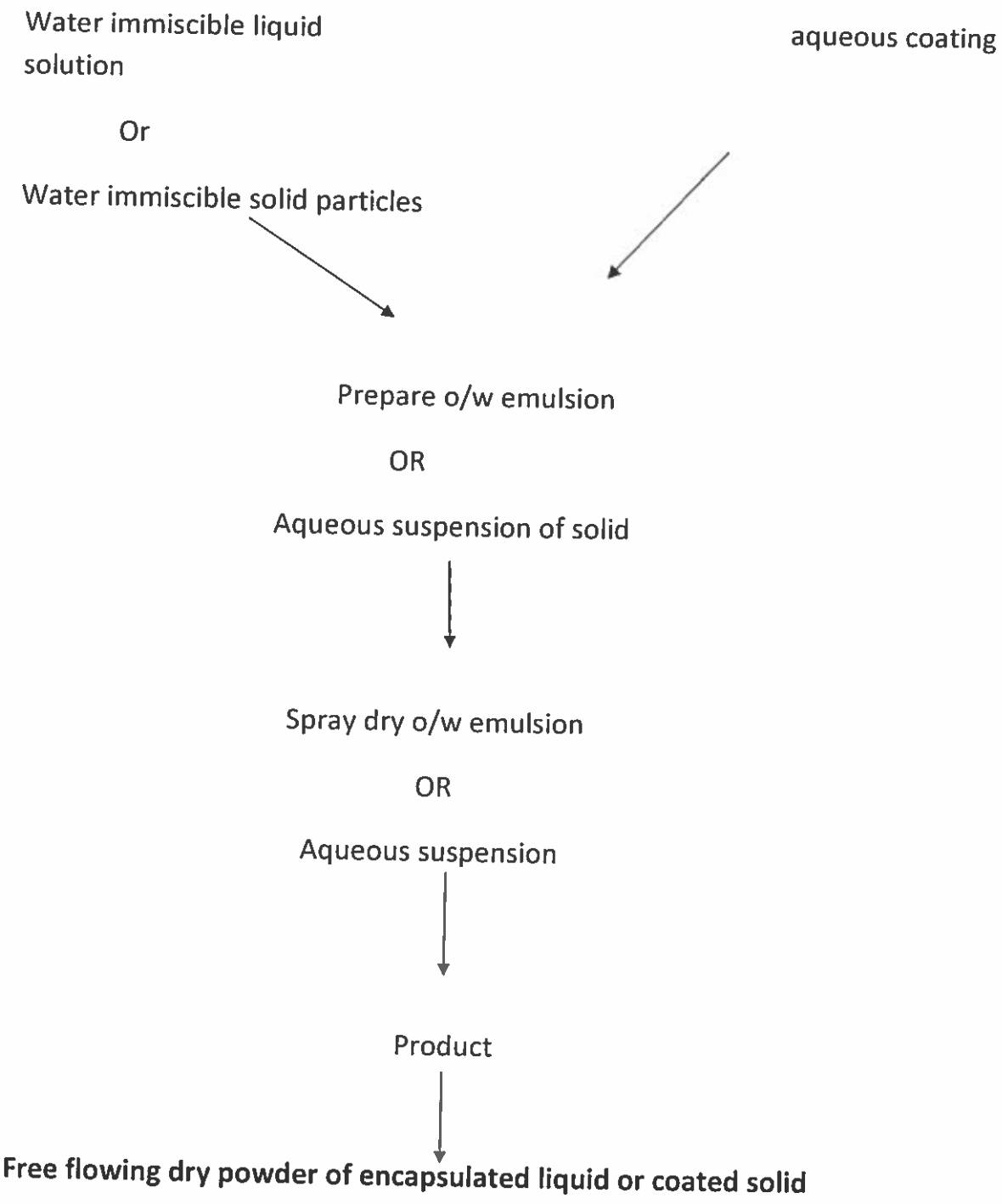
1. Procedures adopted for solids:

In this case, the polymer is first dissolved in a suitable volatile organic solvent. Usually Dichloromethane or acetone is used as organic solvent. Then the drug which is present in the solid form is dispersed in the polymer solution under high speed homogenization. This dispersion is then atomization in a stream of hot air. The atomization lead to formation of small droplets or the fine mist form, from which solvent evaporates instantaneously, leading to formation of microspheres.

2. Procedure adopted for oily liquids:

In this case of oily liquids, coating material e.g. gums such as acacia or starch is added to water to form aqueous coating solution. Then oily liquid is added in the aqueous coating solution to form o in water emulsion. Here acacia act as both coating material and emulsifying agent. Then this emulsion is added in a spray dryer, where first atomization of emulsion and then evaporation of water by hot air is carried out. As the water evaporates, the oil is entrapped in the shell of a gum and thus! **Free flowing powder of encapsulated liquid is obtained**

FLOW CHART OF SPRAY-DRY PROCESS FOR COATING LIQUID OR SOLID PARTICLES



Advantages of spray drying:

It has following advantages:

i. Microencapsulation by spray drying is used for:

.Masking the taste and odor of bitter drug

.Improving the stability of drug product

.For producing the sustained effects of drugs

ii. This process produces microcapsules which are spherical in shape and have free flowing properties.

iii. The particle size of microcapsules is very small. This small particle size give large surface area for heat and mass transfer, thus evaporation is very rapid. Thus actual drying time of droplet is only a fraction of second and the overall time in the dryer is only a few seconds.

Particle size of microcapsules prepared by different encapsulation technique is shown by the following table:

Microencapsulation process	Core material	Approx. Particle size (μm)
Coservation-phase separation	Solid and liquids	2-5000
solvent evaporation	Solid and liquids	5-5000
Spray drying	Solid and liquids	600

iv. Spray drying is more economical than any other process because it produces dry powder directly from liquid and eliminates other processing steps such as precipitation and drying. By the elimination of these steps labor, equipment, cost and possible contamination of product is reduced.

Disadvantages of spray drying:

It includes:

i. The equipment is very bulky and expensive.

ii. The overall thermal efficiency is low because air must be hot enough when it leaves the dryer to avoid condensation of moisture. Also large volume of heated air passes through the chamber without contacting a particle thus not contributing directly to the drying process.

Applications of spray drying:

i. This technique is used to encapsulate various types of antibiotics such as

Penicillin , streptomycin and Aureomycin AND

Sulfaethlythiazole

ii. Oil soluble vitamins e.g. A&D can be coated with a variety of materials such as acacia gum to prevent their deterioration.

iii. Flavoring oils can be encapsulated by this technique and converted into dry flavors.

Spray chilling or spray congealing:

An alternative process of spray drying for the encapsulation of solid particle is spray chilling or sprays congealing.

This process consist of suspending the particles in a molten coating material and pumping the resultant slurry into a spray dryer in which cold air is circulated.

The slurry droplets congeal on coming in to contact with the air and are collected in the same manner as the spray dried product.

Spray dryer:

Components of spray dryer:

The spray dryer consist of following components

1. Feed delivery system

2. Atomizer

3. Drying chamber

4. Air heater (heated air supply)

5. Cyclone or product collector

Working:

The feed (which may be solution, suspension or emulsion) is delivered to the atomizer either by gravity flow or by the use of suitable pump. Atomizer causes breakdown of feed into fine smaller droplets and then these droplets are introduced into fine smaller droplets and then these droplets are introduced into current of warm filtered air in drying chamber. The air supplies the heat for evaporation or latent heat of vaporization to fine droplets, which evaporates the liquid from droplets and converts them into dried product.

Then this dried powder is carried out by gravity flow or by gas current to the collection system. The separation of solid particles from the effluent gas is carried out by cyclone separator. The dried product collected at this point is called cyclone product. Product that reaches the wall of drying chamber is known as chamber product and is removed from the bottom of the chamber. This chamber product is usually coarse in size and usually heated for longer period of time than cyclone product. The final dried product is usually the mixture of both the chamber and cyclone products.

Types of atomizers:

Three types of atomizers can be used in spray dryers.

1. Pneumatic atomizers

2. Pressure atomizers

3. Spinning disc atomizers

1. Pneumatic atomizers:

In pneumatic atomizers liquid feed is broken down into droplets by a high velocity jet of air or other gases.

2. Pressure atomizers:

In pressure atomizers, liquid feed is delivered by pressure nozzle under high pressure into drying chamber and is broken down when it comes in contact with the air or by impact on jet or fixed plate.

3. Spinning disc atomizers:

In spinning disc atomizer, the liquid feed is delivered to the center of rapidly rotating disc (i.e. 3000-50,000 rpm) where centrifugal force breaks the fluid into the smaller droplets. Spinning disc atomizer has important role in the spray drying of pharmaceuticals because of their ability to handle all types of liquid including high viscosity liquids that would clog other atomizers.

Applications of spray drying in pharmaceutical field

Effect of spray drying on powder properties many spray drying operations produce spherical particles while others result in non-spherical particles. Particles may be hollow or solid. Pressure spray nozzles can produce particles ranging in size from 20 to 600 microns. Two-fluid nozzles generally produce particles with sizes in the range from 10 to 200 microns and larger (Kata Gavin, 1976;

Somerfield&Bali, 2001). Rotary atomizers produce more uniform particle sizes compared to pressure atomizers. Co-current dryers produce powders with lower bulk densities than counter-current dryers.

- In general, a spray dried granulation has improved flow, better distribution of drug, colors, etc. and requires less lubricant than wet massed products (Michael, 1993). Spray drying results in a shell of concentrated binder at the surface of the granular material, providing strong tablets and maximum use of binder.
- With spray drying one can co-precipitate an API with a polymer in a stable amorphous solid dispersion, thereby greatly improving the dissolution rate of many drug substances, including tolbutamide, indomethacin and ibuprofen (Gunnison et al., 2008). Complexes of paracetamol and diazepam have been prepared withpcyclodextrin. (3)
- Spray drying's one-step ability to complete the drying process within seconds gives it an edge over other industrial drying techniques. In the food industry, fast drying plays a vital role in ensuring minimum overall flavor loss. The process operates on basic principles and lends itself to automation. The process is versatile and adaptable to a wide range of industries and their feedstock and product specifications. Virtually any feedstock that can be pumped -- solutions, suspensions, slurries, melts, pastes, gels -- can likewise be spray dried.
- Spray drying produces powders of controllable particle size and overall quality. Other characteristics manipulated during spray drying include bulk density, degree of crystallinity and residual solvent levels. Being able to control these parameters makes the process desirable for industries like pharmaceuticals, where the optimum absorption of a drug depends greatly on particle size. In dyestuff production, powders of uniform consistency ensure their convenient dispersion into paint suspensions. The food industry puts a premium on moisture content, which determines a product's shelf life.
- Spray drying racks up huge costs from the equipment required and from its continuous operation. Main and auxiliary equipment are equally expensive, regardless of atomizer type and dryer capacity. Spray dryers generally have

low thermal efficiencies, due to the large volume of hot air that circulates in the chamber without contacting the particles. Additionally, spray dryers that utilize two-fluid nozzles require compressed gas for atomizing.

- Spray dryer maintenance mostly involves issues with the nozzle used. One-fluid and two-fluid nozzles are particularly prone to clogging and abrasion at the nozzle mouth. Rotary disc atomizers, due to the number of moving parts in direct contact with the powders, suffer from internal corrosion. Finally, issues with powders sticking to the internal chamber walls further contribute to cleaning costs and profit losses.