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APPLICATIONS OF FLUIDIZED BED PROCESSING: A REVIEW

B. S. Dawange*, S. S. Pawar, R. K. Surawase and Dr. A. D. Maru

Loknete Dr. J. D. Pawar College of Pharmacy, Manur-423 501.

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***Corresponding Author**

B. S. Dawange

Loknete Dr. J. D. Pawar College of Pharmacy, Manur-423 501.

ABSTRACT

Fluidised bed processing technology emerged as useful application in pharmaceutical industry. The fluidised bed processer was developed in 1950. Formulation development is the most emerging and upcoming face of pharmaceutical technology in the current era. It is contemporarily capturing in the market and bounds with recent trends and development with its innovative techniques. The technology is used for granulation/ agglomeration, layering and coating of a wide range of particle size as well as for drying process. The three patterns of the fluid bed processes could be characterised by the position / location of the spray nozzle i.e. top spray, bottom spray or tangential spray. The aim of present review is to study the general aspects of fluid bed processor which is utilised in pharmaceutical industry.

KEYWORDS: Fluid Bed Processor, Drying, Coating, Wurster Process, Agglomeration.

INTRODUCTION

Most equipment which is used for the process of granulation and drying are being used in present day pharmaceutical industries. Use of such equipment helps reduce the time, cost and also the processing steps involved in production of a product. The latest technology called fluid bed processing helps in attaining the granulation, coating and drying of a product so that uniform coating and drying takes place. The principle involved in such techniques may be either by bottom spray or top spray or tangential spray process. These principles depend on the positioning of the spray gun in the equipment. The top spray process helps in obtaining the uniform palletisation or granulation. The bottom spray process uses Wurster coating unit for the spray (Leuenberger, 1990).

Agglomeration means the conversion of fine solid particles into larger particles by agitating the fine solid particles in the presence of a binding liquid. Generally, 10-30%w/w of binder with respect to fine solid particles is used. The binding liquid provides temporary binding forces by way of liquid bridges and by solid bridges after the solvent evaporation. These solid bridges largely determine the effectiveness of dried agglomerates.[1]

Concept of fluidization

The fluidized bed shows the following properties:

- Lighter particles float on top of the bed
- The beds have a static pressure head due to gravity.
- It has a zero angle of repose.

Fluidized bed processing involves drying, cooling, agglomeration, granulation and coating of particulates materials. It is ideal for a wide range of both heat sensitive and heat resistant products. Uniform processing conditions are achieved by passing a gas (usually air) through a product layer under controlled velocity conditions to create a fluidized state. In fluid bed drying, heat is supplied by the fluidization gas, but the gas flow need not be the only source. Heat may be introduced by tubes/panels immersed in the fluidized layer. In fluid bed cooling, cold gas (air) is used to remove heat. Fluidized bed coating is a process that takes place inside a fluidized bed whereby a coat is introduced to cover the intended object in order to protect it or modify its behaviour. Multiparticulate coating is a form of fluidized bed coating involving the coating of solid particles inside the bed. In this process, a layer is deposited onto the surface of fluidized solid particles by spraying with a solution of the coating material. The fluidizing gas is also use to dry the deposited solution to form a coat on the surface of the particle/ multiparticulates. Today modify fluidized beds are used for coating because of their high energy and mass transfer.

In Film coating process, the aqueous or organic coating solution must be evaporated as the film is deposited. The velocity of a film coat application is related to the drying capacity of the procedure. Fluid bed film covering forms have a more drying capacity than other coating systems because of high fluidizing air volume that is utilized to both suspend the particles as well as evaporating the coating solution.[3]

Theory of Fluidization

- Static bed
- Expanded bed
- Mobile bed
- Bubble formation
- Pneumatic transport

Static bed: When the velocity of the suspending air is low, the supplied air passes through the void spaces of the bed without disturbing the particles by which no air suspension of particles takes place.

Expanded bed: At an intermediate flow rate of the air used, the bed gets expanded in the stream, this is called as expanded bed.

Mobile bed: When the flow of air stream is very high i.e., with high velocity, the particulate bed is swept off to the top of the vessel. This is called as mobile bed.

Bubble formation: When the velocity increases, the bed expands and bubble formation occurs.

Pneumatic transport: This occurs when the air velocity further increases leading to the blowing of the particles out of the stream.[1]

Functions of Fluidized Bed Processor

General

A Fluid Bed system brings powdery or grained substances (Bulk material) in a floating condition; with the carrying air flow enabled to exchange heat and substances with the floating material. The mini quest F is designed as a component laboratory device. There are only few steps necessary to change over the machine tower for the relevant function. Controls occurs via an operating panel on the front side of the device.

Function Principle

Once the material has been charged into the product container the latter is docked to the machine tower. the desired volume flow is adjusted with a process air pressure control valve. Another controller maintains the temperature of the process air on the specified set point. The same principle is valid for top spray granulation and bottom spray coating. However, a spray nozzle is used for the processes. Using a spray air pressure control valve, you can adjust the spray air pressure and thus affect the droplet size arising at the nozzle. The spray rate is adjusted via the speed controller at the spray pump (option).

Fundamentals on the processes

1) Fluid bed drying

During the drying, Process air flows through sieve bottom of the material container and whirls up the material being within it as the air velocity exceeds the setting speed of the particles (fluid bed). The particle ascends within the material container and come in the relief zone. During the flight the full surface of each particle is exposed to the air flow which allows an optimum drying.

2) Fluid Bed Granulation

During granulation process air flows through sieve bottom of the material container and whirls of the material being within it as soon as the air velocity exceeds the settling speed of the particles (fluid bed).

The particle ascends within the material container. Agglomerating liquid is sprayed into the fluid bed from the spray nozzle installed in the relief zone. The granulated particles come further into the relief zone. During the flight the full surface of each particle is exposed to the air flow, Which allows an optimum drying during sprying This process generates dust-free pourable granulates from very fine powders.

3) Fluid Bed Coating (Wruster Process)

During Fluid bed coating, the product is coated with suspension or dispersion. Attention must be paid that the liquid phase of the suspention is not evaporated before the droplet has wetted the particles in the fluid.

For the wruster process, the special design of the material container (With one internal ascending pipe) and the spray nozzle located on the sieve bottom ensure the desired particle movement and the desired spray pattern of the sprying agent. the optimum process is when the product ascends within the ascending pipe in a rapid whirling motion and slowly falls back to the product container bottom out of the ascending pipe.[3]

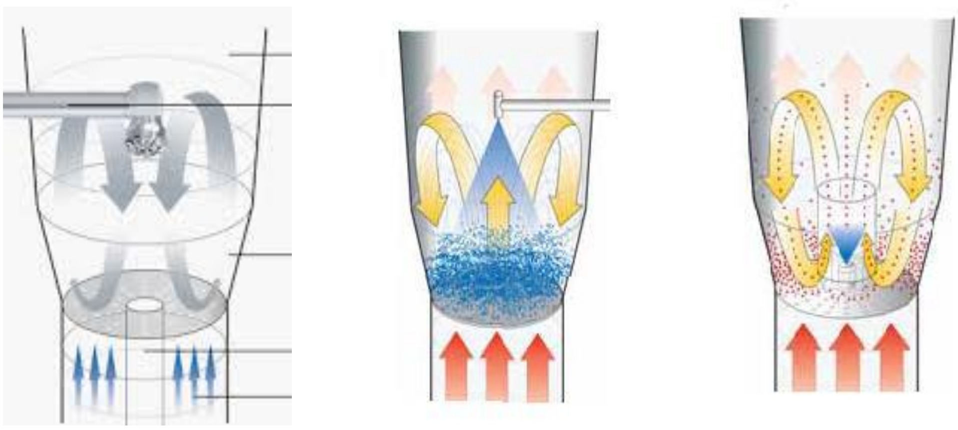

Fig: 1 (a) Fluid bed draying (b) Fluid bed granulation (c) Fluid bed coating

Advantages of Fluidised Bed Processor

1. It helps to achieve Rapid mixing, uniform temperature and concentrations.

2. Liquid like behaviour, easy to control

3. It Controls rapid temperature changes, hence responds slowly to changes in operating conditions and avoids temperature runaway with exothermic reactions

4. Applicable for large or small-scale operations.

5. Continuous operation.

6. Ease of process control due to stable conditions.

7. Heat and mass transfer rates are high, requiring smaller surfaces.

Disadvantages of Fluidised Bed Processor

1. Due to the complexity of fluidized bed behaviour, there are often difficulties in attempting to scale-up from smaller scale to industrial units.

2. Pipe and vessel walls erode due to collisions by particles.

3. Non-uniform flow patterns (difficult to predict).

4. Size and type of particles, which can be handled by this technique, are limited.

5. Particle comminution (breakup) is common.

Processing parameters

A) Drying parameters

- **Temperature:** Rate of drying increases as inlet air temperature increases. This should be carefully monitored as the exposure of the thermolabile substances gets degraded on increasing the temperature of inlet air.

- **Humidity:** Humidity plays an important role in drying of the compound. If humidity is less in the inlet air, the drying process gets completed in a faster rate when compared with that of the inlet air with high humidity.

B) Granulation parameters

- **Position of nozzle:** Based on the bed height, the position of nozzle should be adjusted, for better drying.
- **Spray rate:** Spray rate should be optimized for prevention of over granulation.
- **Spray pressure:** Pressure should be monitored continuously as the change in pressure leads to improper drying and granulation process.

C) Coating parameters

- **Distance of spray nozzle:** Distance of spray nozzle plays an important role in deciding the coating process as the more distance leads to evaporation of the coating solution and the less distance leads to over wetting of the particles or the dosage forms.
- **Droplet size:** Droplet size is inversely proportional to the efficiency of coating. The lesser the droplet size, the more is the uniformity of coating of the solution.
- **Spray rate:** the spray rate should not be too fast or too slow. Optimum spray rate is to be maintained for better coating to take place.
- **Spray pressure:** Atomization of coating solution depends on the spray pressure.

Moisture in the equipment leads to degradation of hygroscopic substances. Coating solution is to be dried well so that uniform coating occurs. So, the temperature should also be monitored for a better coating solution. Time of drying also plays a major role in coating process. If the time of drying increases, the coating layer may get brittle and leads to processing problems and if the coating layer is not well dried, the doublets and the triplets are formed due to the sticking of the tablets to one another.[1]

Applications

1) Top-spray fluidized bed coating is used for taste masking, enteric release and barrier films on particles/tablets. Bottom spray coating is used for sustained release and enteric release and Tangential spray coating is used for SR and enteric coating products.
2) Fluidized bed coaters are used widely for coating of powders, granules, tablets, pellets, beads held in suspension by column of air.

3) The three types (Top spray, Bottom spray, Tangential spray) are mainly used for aqueous or organic solvent-based polymer film coatings.
4) Fluidized bed dryers are used in drying of various materials such as powders, tablets, granules, coals, fertilizers, plastic materials.
5) This process is being used in granulation of pharmaceutical powders.[2]

CONCLUSION

Fluidised bed processing technology has become most commonly used method in pharmaceutical industry. Fluid bed processor offers important advantages over other method of coating and drying of multiparticulate materials. Fluidisation gives rapid and easy drying and coating at high thermal efficiency. So today fluidised bed processing technology shows great results in pharmaceutical industry.

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