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A REVIEW ON FLUIDIZED BED TECHNOLOGY

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Abstract

The formulation development is the key step in the formulation to help in the present day. Such formulation development is the most emerging and upcoming face of pharmaceutical technology in the current era. This review article discusses about the principle involved in fluidized bed processor (FBP) and the latest equipment available in market working on the principle of FBP. The main principle involved in the FBP is the air suspension in which the material to be coated is suspended in the coating material with the help of air stream. Fluid bed process involves three principles viz., top spray, bottom spray and tangential spray. Detailed information regarding the advantages, principles and the latest technology involved in the FBP is discussed in this review. The FBP has a wide range of applications such as drying, granulation powder or particle coating and pelletizing.

Keywords: Fluid bed processing, Top spray, Bottom spray, Tangential spray, Pelletization, Granulation, Coating.

1. Introduction [1]

Now a days FBP (Fluidized bed processor) is an important technology utilized in Pharmaceutical Manufacturing. Initially used as a simple yet highly effective dryer, with the addition of spray nozzle, fluidzed bed systems quickly developed into granulators. The main concept of a FBP granulation is to spray a granulating solution on to the suspended particles. Which then would be dried rapidly in the suspending air. The benefit from this system is the rapid granulation and drying of a batch .In the addition to granulation for tabletting the fluid bed top spray method. Which produces a highly dispersible granules with a characteristics porous structure that enhances wettability such granules are used in food, nutritional and chemical products.

The bottom spray (wruster) fluid bed process preferred for the application of film coating to a wide variety of multiarticulate ; also suitable for drug layering when the drug dose is in the low to medium range. The tangential spray fluid bed process suitable for the application of film coating of wide range of multiarticulate product. The ideal for drug layering is also useful as a spheronizing process for producing spheroidal pellets from powders.

2. Principle of Fluidization [2]

The principle of fluidization is when a gas is sent through a nozzle with a velocity of greater than the settling velocity of particles or solids, the particles tend to suspend in the air provided and continue in the stream of upward gas. When the particles are reaching to the top of the equipment, they tend to gravitational pull and so fall down and the process is suspending continues. This process is called as fluidization of suspended particles.

3. Theory of Fluidization [2, 13]

The following are the stages of fluidization

a. 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.

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

c. 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.

d. Bubble formation: When the velocity increases, the bed expands and bubble formation occurs i.e., Pneumatic transport. When the air velocity further increases leading to the blowing of the particles out of the stream.

4. Instrumentation and Operation[6]

a. Incoming Air: It should be come in contact with the product and free from air born dust oily particles and other impurities. The air should be filtered through both coarse and fine dust filters and also from HEPA filters if required. Cooling with cool water or refrigeration agents or passing through adsorptive agents should dehumidify it.

b. Product Container: The product container should be made up of high quality polished stainless steel having suitable shape and size. The bottom part would be hold as a screen of the correct size required to catch the product. It may be also equipped with discharge pneumatic devices, choppers to break lumps of granules during processing, special film-coating partitions and nozzles to spray fluid from below.

c. Filter Bag Housing: The filter bag & housing are very important parts of fluidized bed equipment. Manufacturers patent the no, design, size, shape and other characteristics of filter bag housing. The filter is a shaking device which is filter below off device and they are used for cleaning the filters.

d. Spray Device: This device is used to distribute the firmly atomized and homogenized granulating or coating liquid on to the fluidized product. One fluid nozzle, which is atomize liquid by its own pressure against the nozzle tip, and the two fluid nozzles which are high-pressure air that is introduced at the nozzle tip to break the liquid into fine droplets. The latter one is most widely used since it places, much finer droplets.

5.Types of Fluidized Bed Technology According to the Position of The Spray Gun [2,3,9]

a) Top spray

b) Bottom spray

c) Tangential spray

5.1.Top spray[2, 9]

This processing option is frequently used by the food, feed and chemical industries as the function of the film mainly serves to improve the general handling or storage time i.e., the time limited protection against moisture, oxygen or light. A perfect film is generally not required for this function, but the most important care should be taken that the droplets do not become too viscous before touching the substrate, In order to maintain a good spreadability**.**

Process variables[3]

Process variables for the top-spray method include the liquid addition rate, inlet air temperature, fluidization air volume, process air humidity, and the atomization air pressure. It should be noted that atomization air volume is the key variable, but it often is gauged by atomization air pressure.

The main effects of process parameters for top-spraying are on the physical properties of the granules were studied. A faster rate of liquid binder addition resulted in a larger average granule size and less-friable granules. An increase in the inlet air temperature caused a decrease in average granule size. In both cases, the effects resulted from an increased ability of the solution to wet and penetrate the solids when the spray rate was increased or when inlet air temperature was decreased. Atomization air pressure also had a significant effect on average granule size. An increase in atomization air pressure will decrease in average granule size because of small liquid droplet sizes**.**

Fractional factorial design was also developed to evaluate granulations prepared in a top-spray fluid-bed processor and it was concluded that atomization air pressure was the most critical parameter, followed by the liquid addition rate, binder concentration, and inlet air temperature, respectively. Fluidization air volume was found to be statistically insignificant. The authors observed significant interactions between some of the parameters.

In summary, The top spray fluid-bed granulation are atomization air pressure (volume) and the liquid addition rate are most critical process parameters. Inlet air temperature, inlet air humidity, and inlet air volume have lesser effects on granule formation; however, good control of all these parameters is important to minimize batch-to-batch variation in production. In addition, the effect of these less-critical parameters may increase as binder strength decreases. Binder type and concentration also play important roles in granule formation, but lie outside the focus of this article.

The top-spray process typically is used in three applications:

1. Granulating with a binder

2. Granulating with water (instantizing)

3. Fluid-bed spray-drying.

Generally, granules prepared by the top-spray method are porous and have a loose structure. They disperse well in water and have lower bulk densities compared with granules prepared by high-shear granulation.

Advantages of top spray

Agglomeration or granulation processes:

- It reduces the amount of fines

- It improves the flow
- It eliminate the segregation
- It distribute the components homogeniously
- It control the bulk density
- It optimize the solubility

Coating process

- It is the lipid coating and taste masking process
- It is also moisture and oxidation protection coatings

5.2.Bottom spray coating[2, 9]

This processing option uses the energies and controls of the fluid bed to create a pneumatic mass transport inside a special insert, which consists of a perforated bottom screen with defined free areas. Most of the process air is channelled through the centre via a tube as such producing a venturi effect, which sucks the product from outside the partition past the spray nozzle. Leave the cylindrical partition and enter the conical expansion chamber. The particle velocity is dramatically reduced, excess moisture is rapidly evaporated with the dry product returning again and again through the coating zone to receive more coating material.

This uniform statistical residence time of all particles in the coating zone results in a very homogenous coating. Due to the nozzle being positioned directly inside the product and concurrently spraying a premature viscosity change of the coating droplet is avoided. The highest possible coating quality are observed. which is imperatively required to produce defined and reproducible drug delivery profiles.

The Wurster bottom spray method makes it possible to attain high- quality results in coating in coating pellets and particles. The combination of the nozzle positioned directly in the product bed and the controlled product motion made possible by the inner partitions results in an extremely quick and thus economical process.

Process variables[3]

Process Variables, In addition to the process variables for top-spraying, there are two important variables unique to bottom-spraying: the partition height and the type of air-distribution plate. Partition height is determined by the particle size, the substrate density, and the desired velocity of particles passing into the coating zone.

Air-distribution plates are available in various sizes and with whole patterns designed to accommodate a wide range of substrates (from 50µm particles to pellets and tablets). Selection of both the air-distribution plate and the partition height for each particular substrate affects the fluidization of the particles. Wurster has discussed process variables for the bottom-spray process.

Advantages of bottom spray

- Aqueous or organic
- Polymer solutions or dispersions
- Controlled release
- Enteric coating
- Coating of very fine particles
- Active ingredient layering

5.3.Tangential spray[2, 9]

This processing technique is with its physical principles quite similar to bottom- spray coating, only that the production motion is provided by a motor driven rotor disc. Otherwise, the quality producing parameters are the same.

Uniform statistical residence time is warranted by defined rotor revolution speed. The coating material is sprayed uniformly inside the rotating product. The rolling motion of the particles provides an even higher separation force, as such preventing agglomeration. However, this high kinetic energy makes it somewhat difficult to coat very small particles and is generally destructive for larger and non- spherical products. The benefits of this processing option are mainly for the layering and subsequent film coating of pellets.

Process variables [3]

In addition to the variables described for top-spraying, process variables for the rotor include - Disk speed, which controls centrifugal force

- Disk gap, the distance from the disk to the wall of the processor, which controls the air volume and velocity responsible for the lifting of particles.

Advantages of tangential spray

Granulation process: It is useful process for improve dissolution behaviour, better compressibility, higher density, spherical morphology.

Spheronization: It is useful process for higher density, production of pellets, higher content of active ingredients.

Layering: Powder layering, narrow particle size distribution

Coating: Film coating, enteric coating, delayed release and hot- melt coating.

6. Factors Affecting On Fluid Bed Technology [4,11,12]

The parameters that affect the final product processed through fluidized bed systems can be enumerated as below.

6.1 Apparatus Parameters[4,11]

1) Air distribution plate Position of the air distribution plate influences the airflow pattern inside the body.

2) Shape of instrument body Annular base gives better product and fluidization.

3) Nozzle height in case of coater and granulator. It plays vital role as in coating, the atomized coating solution should not get dried before reaching the tablet surface.

4) Positive and negative pressure operation

6.2 Process Parameters[4,11]

6.2.1. In Drying Process

The following inlet air parameters are critical, and applicable in all processes of drying, granulation and coating.

1) Temperature - As the inlet air temperature increases the rate of drying increases and vice versa. This approach to increase the rate of drying cannot be used always because some materials are harmed by high temperature, e.g. Ibuprofen liquefies above 60°C temperature of inlet air should be optimized without any impact on product quality. If temperature is high, it leads to blistering. If temperature is low, soft spot can be formed.

2) Humidity - Humidity in the inlet air should be as low as possible and ideally dehumidified air should be used for faster drying rate because as the humidity of inlet air decreases the rate of drying increases.

3) Air flow rate - Air flow rate should be controlled properly in order to get efficient use of drying air. As the air flow rate increases, the rate of drying increases but the cost of drying also increases. If drying air is allowed for sufficient time to remain in contact with the drying material, proper heat transfer and mass transfer takes place and thus drying cost decreases. Air flow rate should not be too fast or too slow but optimized to have efficient drying.

6.2.2. In Granulation Process

Related To Spray Nozzle

1) Nozzle position in relation to material height - Nozzle position is determined on bases of bed height and it should be placed suitably for better contact of binder with the powder to be granulated.

2) Spray rate - It should be optimized otherwise poor wetting/agglomeration of the product will take place hindering the fluidization and quality granule formation.

3) Spray pressure - It is important for proper atomization of binder solution.

Miscellaneous:

1) Pressure drop across exhaust filters.

2) Outlet gas temperature - The above two parameters give indication of the efficiency of the fluidization process. System’s level of efficiency can be drawn from measuring these two parameters.

6.2.3. In Coating Process

Related To Spray Nozzle

1) Distance of spray nozzle - Efficiency of coating depends on the quality of the coating solution. The coating solution should not get dried before reaching the fluidized substances viz. tablet, particles, and granule surface.

2) Droplet size - Quality of the coat depends on the droplet size. So it should neither be too big nor be too small.

3) Spray rate - Flow rate should not be too fast or too slow, but should be of optimized rate for efficient coating.

4) Spray pressure - Atomization of coating solution depends on the spray pressure, thus for proper atomization droplet size should be optimum.

Miscellaneous

1) Moisture content in processing compartment. Moisture should not be present in case of hygroscopic materials.

2) Method used for coating should be chosen on basis of the purpose for which it is used. e.g. SR, ER, etc.

3) Time of drying should be determined on bases of the product and quality of the coat desired.

6.3. Product Parameters[4,11]

6.3.1. In Drying Process

1) Initial moisture content of material - It should not be high otherwise it increases drying time.

2) Batch size - It should be small and optimized based on feasibility.

6.3.2. In Granulation Process

1) Granulating agent - Type of granulating agent is based on selection of solvent to be used in binder solution. This solvent should be preferably aqueous as organic may cause explosions. Binder solution used to granulate the material should be used in optimum concentration so as to obtain good quality of granules. Temperature of granulating agent should not be high otherwise it will be dry before reaching to the powder surface.

2) Starting material - Fluidization of starting material should be optimized for better contact with the granulating agent. If the starting material hydrophobic, hydrophilic granulating agent is to be used for better contact and granulation of material.

6.3.3. In Coating Process

1) Coating agent - Selection of coating agent should be done according to type of coating required e.g. enteric coating, Sugar coating, etc. Solvent should be selected according to the properties of the coating agent. If solvent is volatile, it should be checked for in flammability.

Concentration of granulating agent should be optimized for uniform spreading and droplet formation. Temperature of the coating agent should not be so high that coating solution get dried before reaching to the tablet surface.

2) Starting material - Shape of tablets greatly affects the coating process. In case of powder coating the particles shape and density affects the coating process.

7. Criteria For Process Selection [3]

Selection of a suitable fluid-bed process for a particular granulation or coating application is based on several factors. Each process has its own advantages and disadvantages. Some of the criteria used to choose the right process for a given application include the following.

- Capacity Requirement

For an application that demands a large capacity, the topspray process has an advantage over the tangential-spray and bottom-spray processes.

- Physical Properties of Raw Materials

For granulation of a product that contains several ingredients with significant differences in bulk densities, the tangentialspray process can provide better mixing than can the topspray process.

- Finished Product Requirement

For a coating application that requires a high degree of reproducibility and high quality of film, such as a controlledrelease dosage form, the bottom-spray process is advantageous. Capital cost (if considering equipment purchase). The topspray process is the simplest of the three methods. Thus, the equipment cost is lowest.

- Productivity or Process Time

This factor depends on each application. The top-spray process offers the highest capacity. However, in topspraying, it may take longer to achieve the target coating level because the coating material will be spray-dried to some degree. Hot-melt coating is a notable exception.

- Coating or Loading Level

The bottom-spray process is a very effective way to produce substrate-layered pellets because of its high coating efficiency. The tangential-spray process is a good alternative to the bottom-spray process for high-dose loading applications.

Table 1 provides an overview of the three fluid bed coating processes based on several properties. The table is organized into three groups: process, product, and economic considerations. For both process and economic considerations, the top-spray process is the most desirable. However, for product applications in which film quality, coating uniformity, and coaling efficiency are important, the bottom-spray and tangential-spray processes are more desirable than the top-spray process. In certain applications, one technique is favored over the other two methods.

For example, the top-spray process generally is a good choice for hot-melt coating, and bottom spraying generally is the method of choice for controlled release coating. Tangential-spraying should be considered for producing pellets of high-dose actives. Fluid-bed technology offers a wide range of applications for both granulation and coating. Top-spray, bottomspray and tangential-spray all have unique features are three types of fluid bed processer.

Each method has its advantages and limitations depending on the application. An understanding of each fluid-bed process, the properties of raw materials, and finished product requirements will aid formulators in selecting the optimal process for a given applications.

Table 1: Comparison of the three Fluid bed Coating Processes (where 1 = Least Desirable and 3 = Most Desirable).

Sr.No	Parameters	Fluid Bed Process		
		Top Spray	**Bottom Spray**	**Tangential Spray**
1	Process consideration			
	Simplicity	3	2	1
	Nozzle access	3	1	2
	Scale-up issues	3	2	1
	Mechanical stress	3	2	1
2	Product considerations			
	Surface morphology	1	3	3
	Coating uniformity	2	3	3
	Layering Efficiency	1	3	3
	Product coating capacity	2	3	3
3	Economic consideration			
	Space requirement	2	1	3
	Equipment capacity	3	2	1
	Equipment cost	3	2	1

8. Advantages, Disadvantages and Applications of Fluidized Bed Technology [5,7]

8.1 Advantages [5]

1) Liquid like behavior, easy to control

2) Rapid mixing, uniform temperature and concentrations.

3) Resists 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) Heat and mass transfer rates are high, requiring smaller surfaces.

6) Continuous operation.

7) Ease of process control due to stable conditions.

8.2 Disadvantages [5]

1) Bubbling beds of fine particles are difficult to predict and are less efficient.

2) Particle comminution (breakup) is common.

3) Pipe and vessel walls erode due to collisions by particles.

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

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

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

8.3 Application [5,7,10]

8.3.1. Drying [7]

Fluid bed drying is an especially effective way of drying solids. During fluidization, liquid is withdrawn from the entire surface of every single particle. The advantages: excellent heat exchange, ideal drying time. The product is also dried gently.

8.3.2. Granulation/Agglomeration[5]

Granulated or agglomerated particles are more desirable than fine powders for several reasons. For pharmaceutical products, granulation often is performed

1.To improve flowability.

2.To improve compressibility for tableting.

3.To reduce dust for operator and environmental safety.

4. To improve dispersibility.

5. To improve uniformity by combining all ingredients together, or by distributing low-dose actives uniformly by dissolving and spraying a solution of actives.

Top-spraying and tangential-spraying typically are the methods chosen for granulation. Process conditions in the bottom-spray technique can be adjusted to produce granules.

Principle of Granulation

The powder is fluidized by the hot air in fluid bed granulator. The binding liquid such as solution, suspension is sprayed on the fluidized powder to build liquid bridges among them to form agglomerates.

The liquid bridge that serve to hold the particle together in two ways,

1) by surface tension at the air liquid interface

2) by hydrostatic suction.

The liquid bridges are dried by the hot fluid air to stick the powder together. While the liquid sprayed continuously, the particles grow bigger to a desire granule size. The process is carried out continuously. Finally it forms ideal, uniform and porous granules.

Spray Agglomeration

Fluid bed spray agglomeration is also often in colloquial terms referred to as fluid bed granulation. Powders are fluidized and a binder solution or suspension is sprayed onto the fluidized particles, creating liquid bridges which form agglomerates from the powder. As soon as the desired size of the agglomerates is achieved, spraying is stopped and the liquid evaporated. The structures created by the liquid bridges are then maintained by solid binder bonds (Fig. 4) Whatever has been liquid inside the agglomerates is now void, as such permitting modified size and porosity of the agglomerates for their intended function, e.g. for compression into tables or fast dissolving instant drink applications. The lack of kinetic energy in the agglomeration zone results in light structures with plenty of internal capillaries. The usual size range found on the market is approximately 0.2 to 2.5 mm.

8.3.3. Coating / Powdered Layering (Pelletizing) [5]

The coating of particles is practiced in various industries for several reasons. For pharmaceuticals, coatings are used

1) To mask unpleasant tastes or odors

2) For product identification

3) To enhance stability (e.g., to act as a moisture barrier)

4) To modify or control drug release

5) To improve product flowability.

In general, there are two types of coating applications: film coating (using a wax, aqueous, latex, or organic coating system) and substrate layering. The latter produces pellets or spherical forms of a substrate by layering it, in powder or liquid form (e.g., solution, suspension, or emulsion), onto inert carriers such as sugar spheres.

The pellets are then coated for modified or controlled-release dosage forms. waxes, water-insoluble polymers, and water soluble polymers are grouped into different categories of coating material. Waterinsoluble polymers can be applied via an organic solvent system or an aqueous system such as latex or pseudo latex dispersions. Because of environmental concerns regarding the use of organic solvents, aqueous dispersions have gained popularity.

Fluid bed technology offers different methods of pelletizing depending upon the functionality of the products and the given properties of the substrate. The various methods of pelletizing are as follows:

Direct Pelletizing

Direct Pelletizing involves manufacturing of pellets directly from powder. Powder is mixed and moistened and the powder bed set into centrifugal motion (fluid bed pelletizing in the rotor).The impact and acceleration forces that occur in this process result in the formation of agglomerates (Fig. 5), which become rounded out into uniform and dense pellets and are then dried. Another alternative for direct pelletizing is spray granulation.

Pellets can be automatically dosed and filled into capsules or compressed to form tablets using a suitable formulation. The even shape and surface provide ideal conditions for application of a precise film, in order to achieve controlled release.

Some of the specific properties of the pellets developed by direct pelletizing are round shape with well defined surface; Ideal flow behavior and dosability; Narrow particle size distribution with low abrasion.

Pelletizing by Layering

A starting grain or a pellet can be presented as the starting material. The pellet is built up to the required size and active ingredient content on a layer-by-layer basis by spray application of the layering substance. Powder and binders, suspensions or solutions make suitable layering substances.

The layers are densely and quickly applied during powder layering in the rotor (fluid bed pelletizing), whereby different types of layers can be formed. Active ingredients can be applied in powder form (Fig. 6) or solution form (Fig. 7) on a layer-by-layer basis onto a carrier, and so unite wide-ranging different functions in a single pellet.

Layer-by-layer pellet build-up; around a given starting core provides layered round pellets of dense and even surface with ideal dosability, low hygroscopicity, narrow grain size distribution. The process of layer-by-layer build-up of ingredients give an edge in formulation development allowing different active ingredients to be coated at different layers to tailor-made the release as well as to maximize the Therapeutic benefi.

Pelletizing by Spheronizing

This processing option is the eldest known industrial pelletizing technique. First all ingredients are blended, then by adding liquid a wet dough is formed, which is passed through an extruder with defined dye sizes. If a thick-wall extruder (approx. 4 mm) is used and the ratio liquid/solids is well adjusted the extrudates break up into 1mm particles during the beginning of spheronization, warranting a high yield of homogenously sized pellets. However, minimum

Particle size is limited to about 500µ. Despite a high reproducibility this is a somewhat tedious process as it involves many process steps, i.e. dry blending, wet massing, extrusion, spheronization, drying and involves different equipment with a large total product contacting surface.

The mentioned process led to development of spherical pellets from granulates (Fig. 8) or extruded products (Fig. 9). Needless to say that the surface of the produced pellets will be smooth; as the intensive rolling movement is involved in the production of the same.

The uniform particle size allow for an equally uniform subsequent functional coating. In many pharmaceutical applications the uniform particle size is often only achieved if the formulation includes 20-50% of microcrystalline cellulose.

9. Innovations in Fluidized Bed Processor [4]

9.1. Pulsed Fluid Bed Dryer[4]

In pulsed fluid bed dryer, at a given time period, the fluidizing gas flows through a fraction of grid surface area and is then redirected to consecutive sections in fast succession (the gas plenum chamber is divided into several sections). While in conventional fluid bed dryer, the fluidizing gas flows through the entire surface area of grid surface.

Advantages

- For easy fluidization for irregularly shaped particles such as fibers, flakes, needles
- For fluidization of material having a wide particle size distribution
- For fluidization of bed of particles with 30 to 50% less air
- It operates with improved fluidization uniformity (reduced channelling)
- For fluidization of fragile particles

9.2. Fluidized Spray Dryer[4]

The Fluidized Spray Dryer FSD™ is one often most successful designs of spray dryers combines fluidization and spray drying technologies, enabling the size and structure of particles to be easily controlled. Therefore, the FSD™ is often used as a spray dryer agglomerator or spray dryer granulator.

Another important feature which makes this concept ideal for producing heat sensitive products in dried form.

Advantages

- Produces free flowing powders in agglomerated or granulated form.
- Produce powders having a very low content of small particles (dustless).
- Many thermoplastic and hygroscopic products those are problematic in other designs can be dried.
- Ideal for heat sensitive products as particle temperatures are kept low throughout the drying process.
- Drying is completed at low outlet drying temperatures, giving high energy utilization efficiencies. 7.3.

9.3 Precision Granulation [4]

Fluid Bed Granulation and High Shear Granulation are presently the most important wet granulation techniques employed in the pharmaceutical industry.

Precision Granulation TM, a new bottom spray method, is evaluated for comparison with the conventional granulation methods.

The objective of this study was to compare Precision Granulation™ (PG) with Top Spray Fluid Bed Granulation (TS-FBG) and High Shear Granulation (HSG) for tabletting.

Finally they conclude with:

PG produced good quality granules with adequate flow and strength for tabletting. The quality of these tablets was comparable to those of tablets prepared from TS-FBG and HSG

Porosity, strength, bulk density and tapped density of PG granules were intermediate to those of HSG and TS-FBG granules. PG granules had the lowest Carr index and Hausner ratio values. For equivalent tablet weight and hardness, PG tablet batches showed faster disintegration times.

Preliminary studies with the two grades of lactose and powdered sugar suggested that PG can offer an alternative to existing methods for investigating granulation of "difficult-to-granulate" materials.

Real Time Process Determination TM (RTPD) is a software program that can be integrated with the granulator controls system for enhancing process monitoring and control.

9.4. Multi-Function Fluid-Bed Granulator and Coater[4]

Vanguard's VPL Series Fluid Bed Granulators and Coaters have multi-functional systems. The top spray system is the third generation of the top spray granulator. It is more efficient than most common fluid bed granulators in the industry. This type of advanced series equipment integrates three fluid bed processes including the top-spray granulating, bottom spray coating, and tangent spray pelletting and coating such that it achieves both economic and technological advantages in solid dose processing and other applications.

Features

- High efficient dryer
- Granulator meeting different requirement
- Bottom spray coating system
- Tangent spray rotor system for powder layering, pelletting, coating
- Intelligent control system
- 2 bar shock resistant as standard

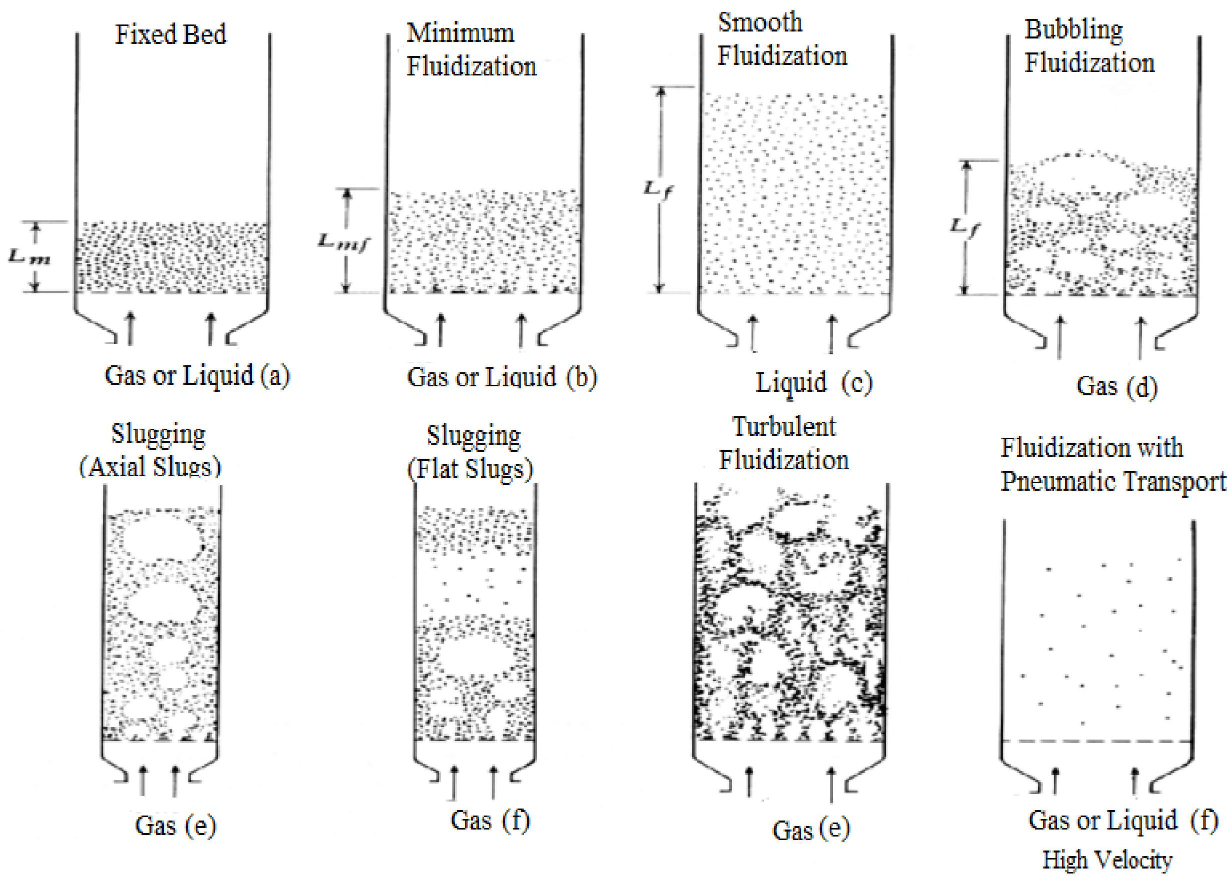

Fig.1. Stages of Fluidization.

a. Top spray b. Bottom spray c. Tangential spray

Fig.2. a. Top spray, b. Bottom spray, c. Tangential spray.

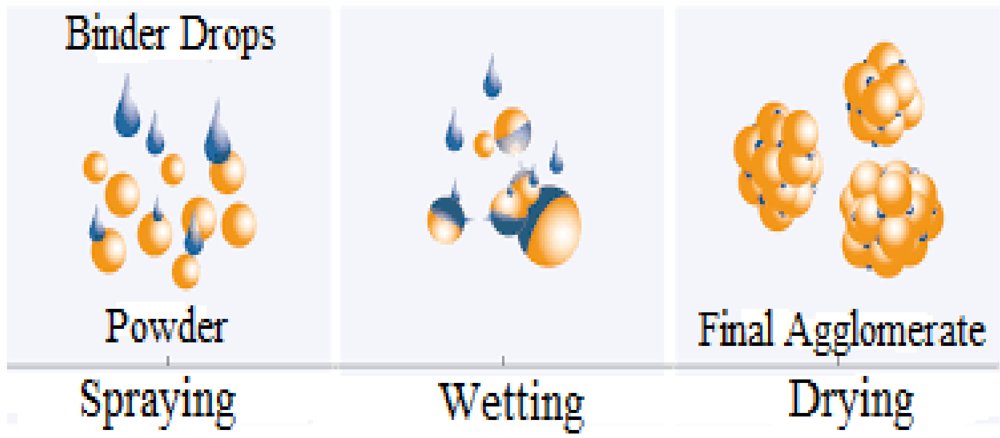

Fig.3. Process principal of drying solids.

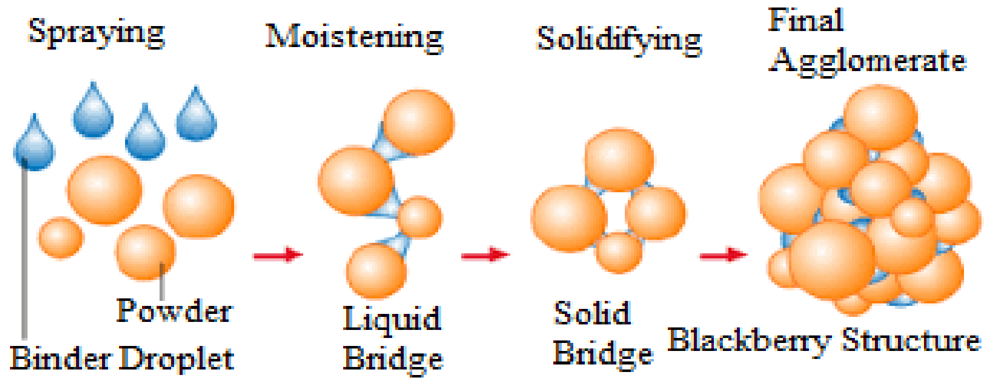

Fig.4. Process Principle of Spray Agglomeration.

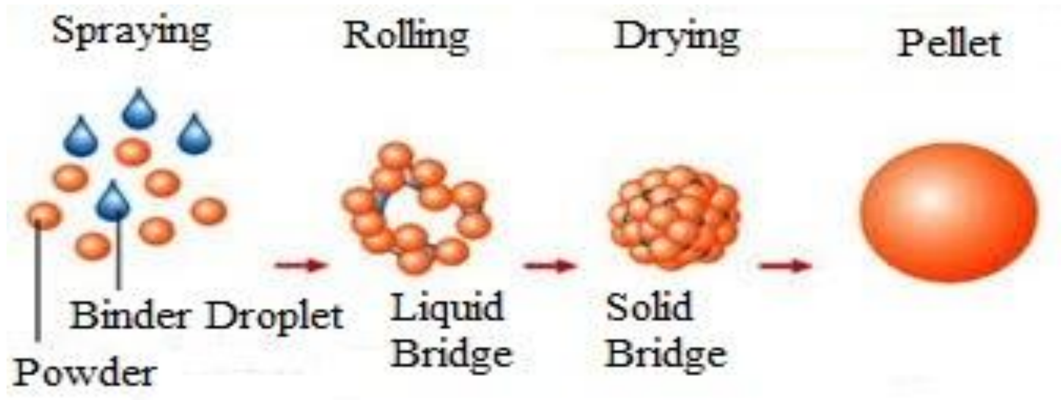

Fig.5. Process Principle of Direct Pelletizing.

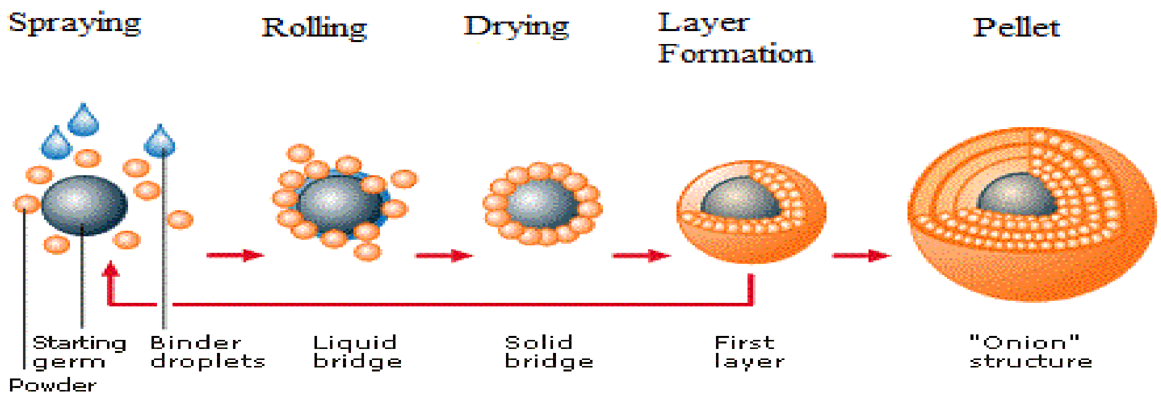

Fig.6. Principle of the Powder Layering Process.

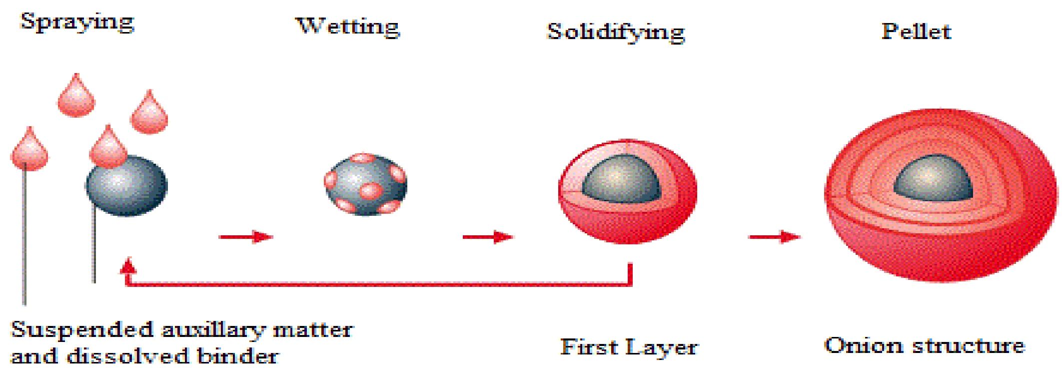

Fig.7.Principle of the Suspension and Solution Layering Process.

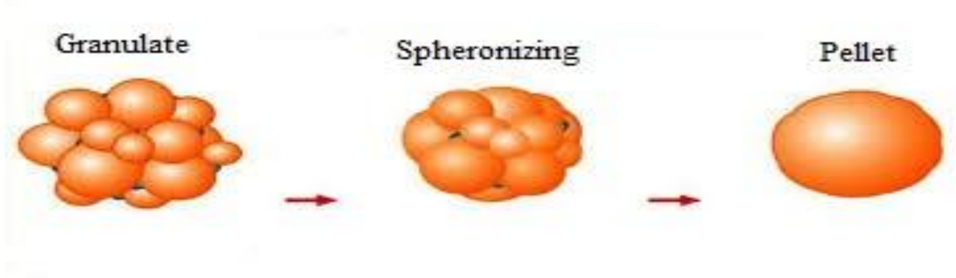

Fig.8. Principle of the Granulate Spheronizing Process.

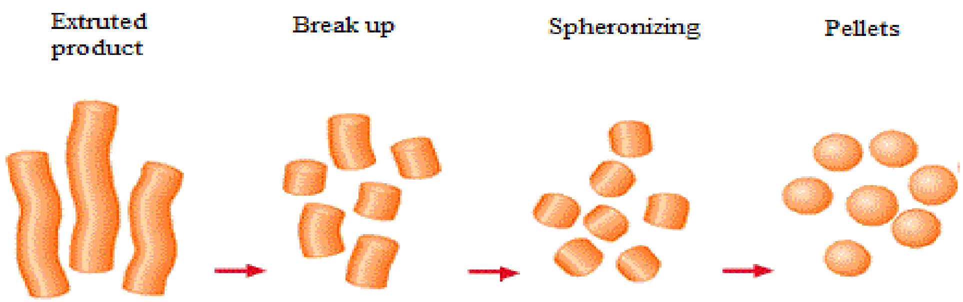

Fig.9. Principle of the Extruded Product Spheronizing Process.

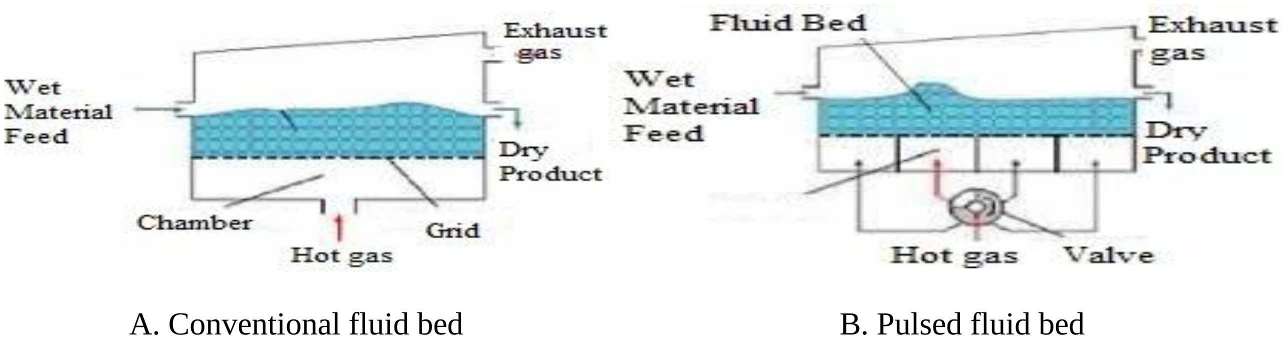

Fig.10. Comparison between conventional and pulsed fluid bed dryer.

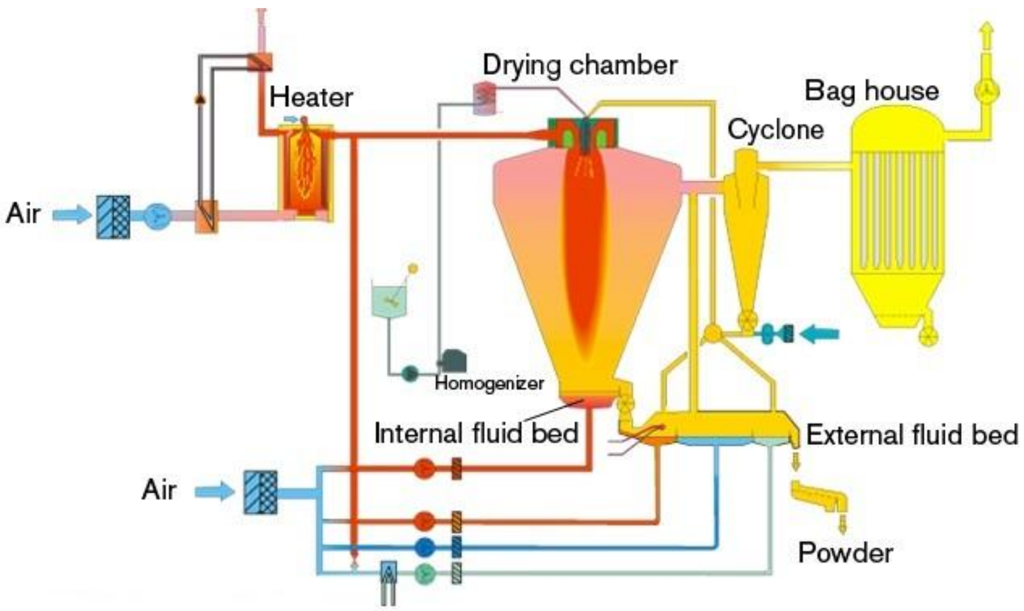

Fig.11. System layout.

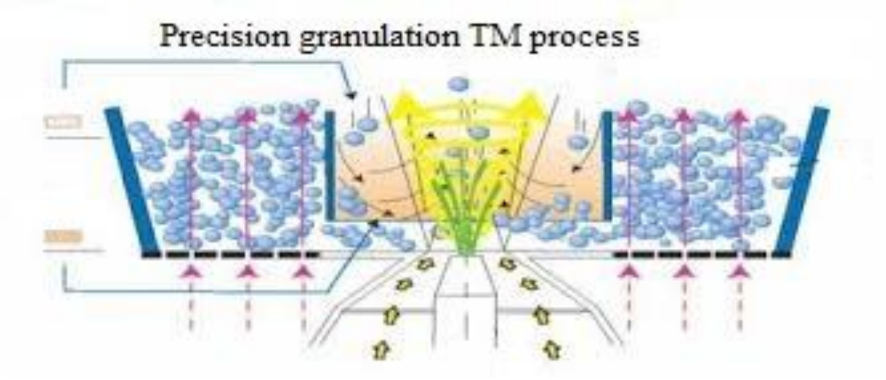

Fig.12. Precision granulation process.

Conclusion

The purpose of this review article is to get knowledge of fluidized bed technology. In this review article we try to discuss the principle and application of the fluidized bed technology also presented a varied description of the fluid bed process such as drying, granulation, coating and pelletization. We focused on types, factor affecting on Fluidized bed technology, and Criteria for selection of fluidized bed technology.

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References

1. Remington, The science and practice of pharmacy, pharmaceutical press, Twenty-second edition, 956,984
2. R.T. Pusapati , V. Rao , Fluidized bed processing: A review, Indian Journal of Research in Pharmacy and Biotechnology, 1360-1365.
3. S. Srivastava, G. Mishra, Fluid Bed Technology: Overview and Parameters for Process Selection, International Journal of Pharmaceutical Sciences and Drug Research, 236-246.
4. Dr.M. Gohel, Dr.R. Parikh, Fluidized Bed Systems: A Review, Pharmainfo.net.
5. G.V. Pulgamwar, R.S. Pentewar, Fluid bed technology: a review, International Journal of Pharmaceutical research and Bioscience, 89-110.
6. J. Chauhan, P. Yadav, Study of Scale up parameters of Fluidized bed Coating, Pelagia Research Library, 228-238.
7. W. Glatt, Fluid bed systems, Glatt, 1-20.

8. L. Lachman, H.A. Lieberman, J.L Kanig, Third edition “Granulation” , The Theory and practice of industrial pharmacy,Verghese Publishing House, Bombay, 5859, 1991.

9. Anitha Sri S, Fluidized Bed Processing Technology: A Short Review, Research and Review Journal of Pharmaceutics and Nanotechnology, 2016;1-4.

10. F. Miniquest, Instruction Manual ACG pharma Technologies pvt. Ltd.

11. G.S. Sonar, Wruster technology-process variables involved and scale up science, Innovations in Pharmacy and Pharmaceutical Technology, 101-105

12. V. Saini, fluidized bed processing for multiparticulates, RJC, 448-450.

13. B.S. Dawange, S.S Pawar, Applications of fluidized bed processing: a review, World Journal of Pharmaceutical Research, 414-420

14. Fluidized bed technology, Neuhaus neotc.

15. M.E. Aulton, Pharmaceutics: The science of dosage form design, Edition 2, Churchill Livingstone, Edinburgh, 2002; 373.

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