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Fluidized Bed Processing Technology: A Short Review

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Review Article

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ABSTRACT

The Fluidized bed processor was developed in 1950 and it was one of the unique equipment widely used in Pharmaceutical Industry. At the beginning of its invention, it was used as a simple dryer and later on became highly effective with various modifications like, addition of Spray nozzles, granulators, bottom spray, rotor technology etc. With the development of rotor technology, the fluid bed system was used to manufacture pellets.

The speed of the operation, the capacity to control variables, the consistency of the coat delivered, and the way that it can be utilized to coat pellets which vary in size. Shape and density are the principle points of interest of the procedure. Further, the procedure does not limit either the sort of coating materials utilized or the solvents used in the coating liquids. Indeed, even chemical reactions intended to deliver polymer coatings from monomer solutions can be effectively done in this dryer. Since it has the capacity to control the variables of the procedure the technique is adequately adaptable and flexible. Subsequently the procedure can be used to coat medicinal tablets or other pellets and to make compacted tablet granulations.

INTRODUCTION

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 [1-9]. 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 [10-17].

The Wurster procedure has been utilized for quite a long time to coat particles, spheres, granules, and tablets. Modifications have been made for use with different coating formulations, including aqueous/non-aqueous solvents and hot melts [18-26]. The fundamental idea in Wurster coating is to isolate the particles in the fluid bed from each other in stream of air. As the particles are suspended in air, the coating solution is sprayed from the bottom of the bed up onto the particles (bottom-up spray) [27-35].

TYPES OF FLUIDIZED BED SPRAYING TECHNIQUES

With the modifications made in the Fluidized Bed Dryer, the spraying techniques are divided into three types: 1) Top spray process 2) Bottom spray process 3) Tangential spray process.

Top spray process

Top spraying is the common process for wet granulation, and it has been widely used in various industries since 30 years. In top spray method, the processor has three components: An air handling system, which can be connected to a humidifier or de-humidifier and dew point control [36-45], a product container with an expansion chamber, an exhaust system [46-52]. The Granulation nozzle used in top spray process and the method of processing has been shown in **Figure 1a and Figure 1b.**

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Figure 1a: Granulation nozzle

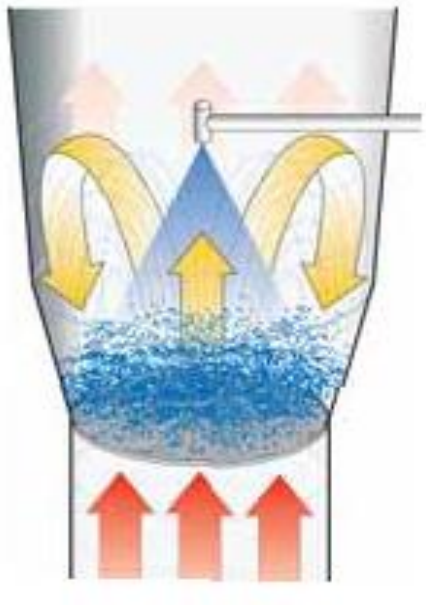

Figure 1b: Top spray process

Bottom spray process

Bottom Spray process is the most commonly used fluid bed process for coating in pharmaceutical industry. Bottom Spray process was developed by Dr. Dale Wurster in 1950 and hence it was commonly known as Wurster process.

Wurster process **(Figure 2a)** features a columnar coating chamber which is divided into two zones namely the inner zone and outer zone [53-62]. The inner zone is exactly half the diameter of outer zone **(Figure 2b).** It consists of an air distribution plate with holes for the air to pass. It also hosts a spray nozzle located at the center for applying the coating solution. The whole system is connected to a control unit, which controls the process taking place [63-72].

The coating process is done by taking the tablet cores **(Figure 2c)** in the coating chamber. A stream of air is passed through the air distribution plate which causes suspension of the tablet cores at the centre of the column. At the same time, coating material is sprayed through the nozzle to coat the suspended tablets. The inner partition wall causes deceleration of the suspended tablets. These suspended tablets fall towards the chamber wall and move downwards to re-enter the air stream at the bottom of the chamber. These are then fluidized again and the cycle is repeated several times until the tablet core is completely coated and the desired coating thickness is

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achieved [73-78]. The supporting air stream serves as medium for suspending the material and also facilitates drying of the coated tablets **(Figure 2d).**

Though Wurster process possess excellent drying effects and produces a product with uniform coating and high gloss, but certain tablets core which undergo edge abrasion and chipping due to their friable nature are difficult to coat even under normal conditions.

Figure 2a: Wurster Process or Bottom spray

Figure 2b: Wurster inner partitions

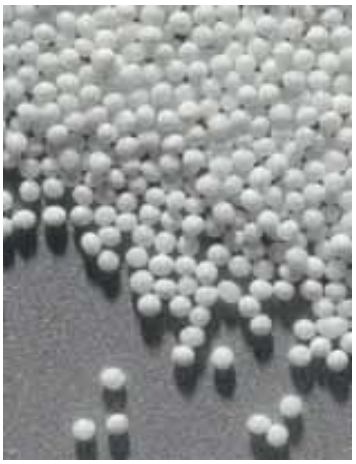

Figure 2c: Core particles

Figure 2d: Coated particles

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Tangential spray process

The processing technique and physical principles are quite similar to bottom spray coating, only that the production motion is provided by a motor driven rotor disc **(Figure 3a).** The spraying nozzles are located tangentially in the chamber **(Figure 3b).**

A significant advantage of tangential spraying **(Figure 3c)** over top spray or bottom spray processes is the option of connecting a powder feeder to decrease the exposure of compounds to water or solvent. This technique permits the production of pellets with high dose loading of activities in relatively short time. Tangential spraying can be used to produce granules or pellets that require successive coating for controlled release [79-85].

This process is most suitable for preparing spheres (spheronized granules) from powders. It also serves the purpose of applying modified release coatings and drug layering.

Figure 3a: Rotor insert

Figure 3b: Rotor nozzle

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Figure 3c: Tangential spray in the rotor inserts

APPLICATIONS OF FLUIDIZED BED TECHNOLOGY

Drying

Fluid bed drying is most effective way to dry solids. During fluidization, liquid present on every single tablet/pellet surface is completely withdrawn. The advantages of this process include ideal drying time and excellent heat exchange. The product is also dried gently **(Figure 4)** [85-92].

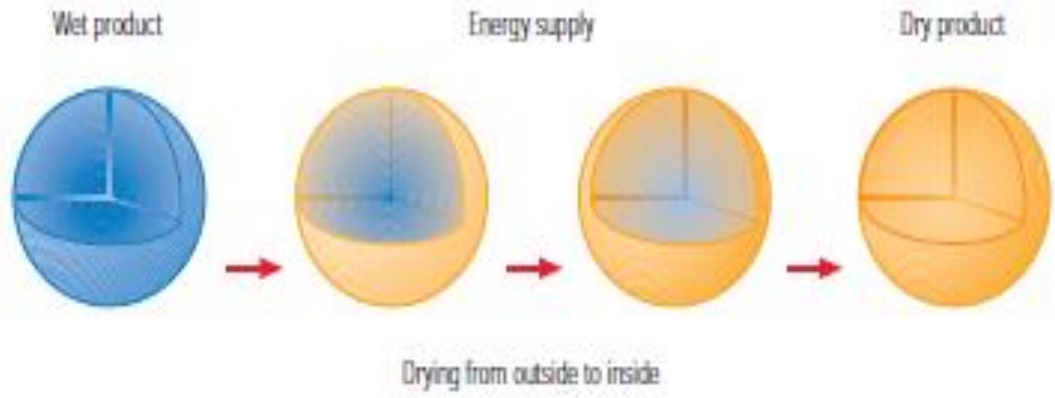

Figure 4: Drying of the pellet

Granulation/Agglomeration

Agglomeration in the fluid bed is a modern method of forming granulates from powder with the help of liquid bridges. The sprayed liquid can be either water, an organic solvent, powder dissolved in solution or another binder. The moist granules are dried, and if necessary cooled [93-95]. As a result of relatively low mechanical forces in the fluid bed, the agglomerates/granulates are loose, outstandingly soluble in water and have a low bulk density **(Figure 5).**

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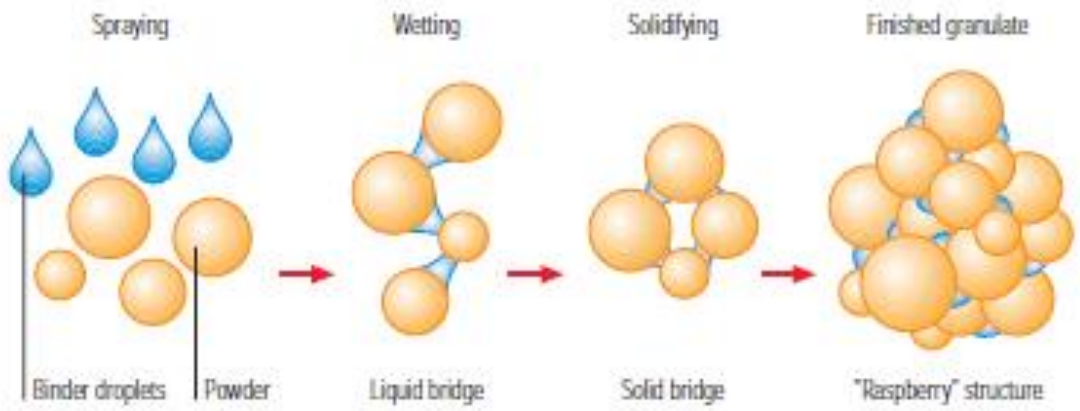

Figure 5: Agglomeration of the pellets

Powder coating/Particle coating

Modern film coating influences the product characteristics through the application of protective films. A uniform application of the coating material is the main feature to be considered during coating. The coating must provide an absolute seal without any mechanical damage or tears. Film coating **(Figure 6)** is a demanding process that can be used over a wide spectrum [96-98].

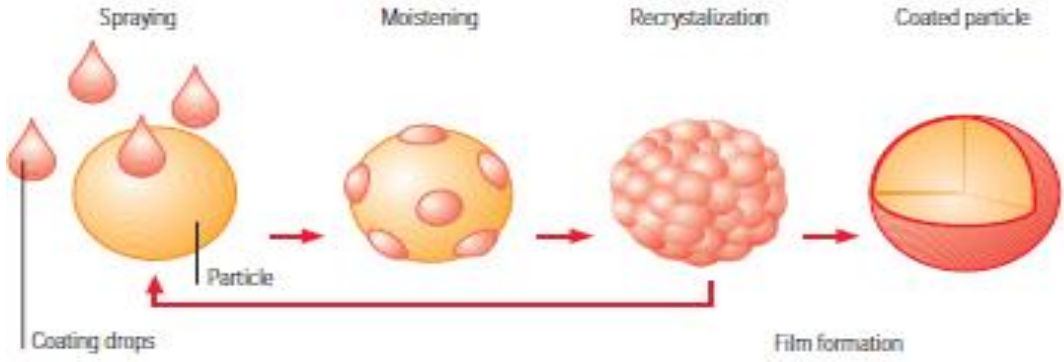

Figure 6: Coating of the pellets

Pelletizing

For pelletizing, the powder is mixed and moistened. At the same time, the solvent or binding agent was added. The centrifugal motion of the powder along with the solvent produces agglomerates, which are spheronized into uniform pellets. Product characteristics can be determined through direct pelletizing **(Figure 7).**

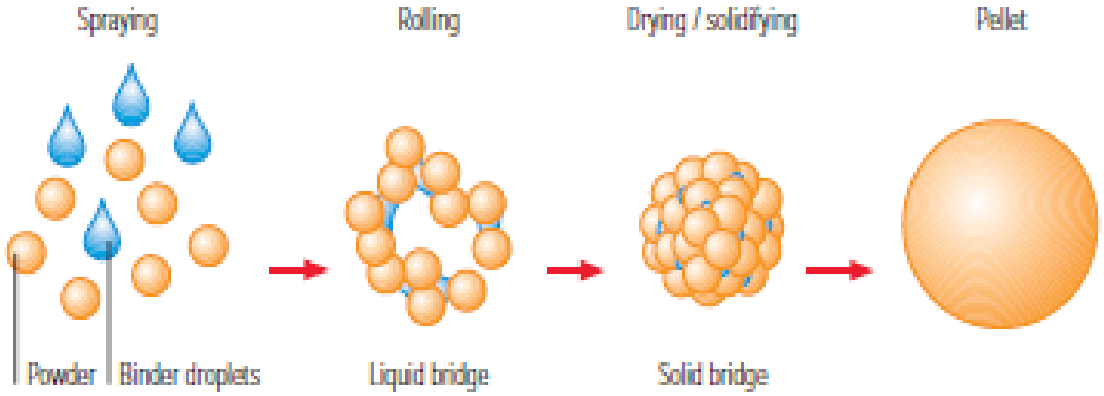

Figure 7: Process of Pelletization

DISCUSSION AND CONCLUSION

Fluidized Bed Processing technology has become the most commonly used method in Pharmaceutical Industry. The adaptability of the product to addition and deletion of other parts like nozzles, inserts etc. it has a wide spectrum of applications which include various pharmaceutical operations like drying, coating, agglomeration, pelletizing, etc. One of the main advantages of this process is that it can be used both in Pilot and Production scale application [99,100]. As the Fluidized bed dryer can acclimatize various sizes of nozzles, it can be used for various spray patterns that vary from medium spray to fine spray.

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