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Short communication

Roller compaction technology

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Introduction

Dry granulation is method of choice when materials have sufficient cohesive properties or inherent binding to form granules and also for newly synthesized active substances that is characterized by fine particles of low density, poor flow and uneven shape and size. In most cases, the characteristics of the active substances are unfavorable in terms of formulation development and production process. Good rheological characteristics of the mixture are necessary for the production of solid forms. This means that it is often necessary to change the morphological characteristics of active substances which usually consist of fine particles (less than 150 μm in size) to obtain a mixture with favorable characteristics like desired particle size range and distribution with appropriate flow and compactability for subsequent stages of production. This literature review covers current technological achievements related to roll compacting devices for dry granulation, their principle of operation, advantages and challenges of this technology in various applications relevant to the pharmaceutical field (Rana, 2011).

Basic principles and mechanism

Roller compaction is a dry granulation process in which the powders containing active ingredients and excipients are added through feed system (feeder screw) that transfers material to the rollers and then pass through. and are agglomerated between two rollers of the same diameter that rotate in the opposite direction. The friction between the material to be processed and the surface of the roller carries the material into the narrow space between the rollers (nip region), where the material is exposed to high pressure which leads to the formation of a compact mass. In the basic design of a roller compactor, there is also an in-line granulator in which the compact obtained from the roller compactor is crushed into granules of uniform size and it processes a large amount of material in a short period of time (Perez-Gandarillas, 2014). Optionally, there are additional systems that improve process control. In dry granulation, compaction strength and uniform distribution are necessary in order to achieve granules of uniform porosity from which the final product of good hardness and disintegration is obtained. The granules produced are usually an intermediate and are later used in the tableting or encapsulation process (Rowe, 2016).

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Discussion

In the pharmaceutical industry, different roller press designs are used. Each technology has its advantages and weaknesses depending on the raw material properties. In general, the orientation of the screw will define how the powder must be fed. For noncohesive powders, vertical feed systems, which are dependent only on the gravity, tend to maintain a uniform powder fill weight into the compaction zone with a small loss of powder. On the other hand, for light bulk density materials (fine powders), the horizontal or inclined feedings force the material to be drawn into the compaction zone by using a screw. In addition, for poorly flowing powders, a vacuum de-aeration system is often used to improve the delivery of material to the rollers. Vacuum de aeration system is one of the sophistications in roller compaction technology and it builds up a vacuum and absorbs the material to be compacted from screw feeder. In order to limit the loss of powders from the roll sides, roller presses are generally equipped with a sealing system (Dhumal et al., 2013).

The results in the literature showed that the percentage of fines is a critical attribute during the

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production and that is highly affected by the roll-compaction and milling conditions and that the roll compaction effect is predominant over the milling effect for the generation of fines. Because of this effect, there is another innovation in dry granulation that is known as pneumatic dry granulation developed by Atacama LabsOy (Helsinki, Finland). Pneumatic dry granulation is an innovative dry granulation technology which, in addition to roller compactors, consists of air sorting systems for the production of granules, which are characterized by excellent flowability and compressibility. In this method, granules of powder particles are produced with the initial application of compression forces using a roller compactor, which produces a mixture of compact and fine particles. Fine particles are separated from granules of the predicted size in the gas flow fractionation chamber (pneumatic system), where granules of the predicted size pass through this chamber and continue until the next phase. The fine particles and small granules are then transferred to a device such as a cyclone and either returned to the compaction roller for immediate processing (recycling process) or later taken to a processing container to achieve the desired granule size (Shanmugam, 2015).

Conclusion

The roller compaction process is designed to improve flow properties, increase bulk density and ensure uniformity of formulations by preventing segregation. It offers advantages over wet granulation for processing materials that are physically or chemically sensitive to moisture because no liquid binder is required. This technology is also suitable for compounds with low melting points or substances, which decompose quickly when heated, as there is no need for a drying phase.

In addition, roller compaction can be the key to achieving a continuous granulation process. Increasingly, the pharmaceutical industry is introducing continuous processing of many products at many manufacturing sites.

The technology is already well adapted to these changes, if the product can be tableted, it can usually be compacted on a roller compactor, although more complex formulations and challenging APIs will require sophisticated roller compaction systems. While a feeder system can aid in homogenization in some cases, it is essential that the homogeneity of the mixture is determined before filling the machine. There are still potential problems with this technology such as proper material flow and material compressibility. Improvements in technical processes such as vacuum deaeration and pneumatic dry granulation can solve these problems and provide solutions to them.

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