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REVIEW ON PAN COATING

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ABSTRACT

Tablet coating machines are technical equipment's that applies a fundamentally dry, delicate layer of coating material over the surface of the tablet. However, this method accomplishes certain benefits over the uncoated tablet. There are various types of tablet coating machines on the market right now. Each of them possesses exceptional qualities in their own right. Now a days coating of pharmaceutical formulations including tablet coating have been subject of remarkable developmental efforts aiming to ensure and enhance the final product quality.

KEYWORDS: Tablet coating, types of coating, coating equipment's, defects and evaluations.

1. INTRODUCTION[1,2]

Coating of tablets is one of the oldest pharmaceutical methods still is existence. Coating is a procedure by which a basically dry, outer layer of coating material is used on the surface of a dosage form in order to confer specific advantages over uncoated variety. It includes application of a sugar or polymeric coat on the surface of the tablet. The benefits of tablet coating are taste masking, odour masking, physical and chemical protection, shields the drug in the stomach, and to control its drug release profile.

Tablet coating can be defined as a process of applying an edible paint on the surface of a therapeutic dosage form to achieve specific profits. This is a supplementary process in tableting which causes an improve in the cost of tablet manufacturing. Coating can be used to several kinds of solid dosage forms like tablets, pellets, pills, drug crystals, etc. When a coating solution is used to a batch of tablets in a coating pan, the exteriors of the tablets get enclosed with a tacky polymeric film. The tablets are then acceptable to dry and the film eventually forms a non-sticky dry surface. The coating method involves parameters such as the spray pattern, drop size, and nozzle spacing (in addition to multiple other non-spray related parameters) which must all be precisely controlled in order to confirm uniform spreading of the coating material.

1.1. HISTROY OF TABLET COATING[3,4]

In the 9TH century Coating process was first started. A variety of material was used to coat pill, such as sugar, talc, and gelatin. in 1856The first sugar coated pill produced in the United States came out of Philadelphia. in the 1880 Coating resistant to enteric or gastric fluid was developed. In the year 1954 the Film coated tablets was marketed for the first time. Coating solution was distributed through the bed of tablets by using rotating pan technique. The major drawback of this technology was that, prolongs the drying time of tablets.

"Panning" was the initial term for the process of coating a tablet. The word panning is still a common term which is used in the confectionary business. In past years coating perform mostly by using a rotating drum (pan) on a stand. A coating solution was used, while the rotation of the pan distributed the solution throughout the surface of tablets. The main drawback of this technology was slow waiting for the coating solution to dry; and the trick was to get it to dry uniformly. With the advent of film coating a layer or thin membrane, usually about 1-3% of the total tablet weight, was sprayed on by means of a perforated pan. To decline the overall procedure time, holes were made through the pan so that treated air (hot or cold) could be pulled through the pan, such as clothes dryer, allowing the tablets to dry more rapidly. With this advent of enhanced drying came the ability to switch the film coating solution from a solvent based solution to a water-based solution. From many centuries Coating of pharmaceutical dosage forms has been practiced.

1.2. Significance of Tablet coating[5-7]

The coating method depends on the following parameters such as the spray design, size of droplets, and nozzle spacing etc. These are well controlled to get uniform coating film.

1. To bury unpleasant odour and taste of the tablet.
2. Shields the drug to enhance stability.
3. Overall shielding of the drug.
4. To increase the stability.

5. To protect an acid labile drug in the acidic medium.
6. To improve the packaging rate and decreases friction between the tablets when the tablets are packed on high-speed packaging machine.
7. Drug release design can be altered.
8. Mechanical strength of Tablets gets enlarged.

1.3. Coating Process[8]

It is most necessary that the coating should be uniform and crack free under stress. Hence, various procedures were designed for the application of the coating on the tablet surface. Usually, the coating solutions are sprayed onto the uncoated tablets as the tablets are being mixed in a pan, fluid bed, etc. As the solution is being applied, a thin layer is formed which sticks to each other. The fluid portion of the coating solution is then evaporated by passing air over the surface of the tumbling pans. The coating may be formed either by a single layer or may be developed in films through the use of multiple spraying cycles.

1.3.1. Sugar Coating

Coating of Tablet was developed originally from the use of sugar to hide the taste and provide an attractive appearance to at the core. The process of tablet coating consists of various steps, which are discussed below:

1. **Sealing**: A seal coat is applied on the tablet to avoid moisture penetration into the tablet core.
2. **Sub coating:** This step is done to around the edges and rises the tablet weight.
3. **Syrup Coating:** The imperfections in tablet surface are covered up and the predetermined size is achieved. This step requires the maximum expertise.
4. **Colouring:** Gives the tablet its final colour.
5. **Polishing:** Powdered wax (beeswax or carnauba) is applied to provide a desired luster.

1.3.2. Film Coating

As the sugar-coating method is very time consuming and is dependent on the skills of the coating operator, this method has been replaced by film coating process. The procedure involves spraying of a solution of polymer, pigments and plasticizer onto a rotating tablet bed to form a thin, uniform film on the tablet surface. The selection of polymer mainly depends on the desired site of drug release (stomach/ intestine), or on the desired release rate.

1.3.3. Organic Film Coating[9,10]

Organic solvent-based coating provides a variety of suitable polymer alternatives, as most of the polymers are soluble in the organic solvents. But there are certain drawbacks like they are flammable, toxic, and expensive and possess environmental problems. ICH guidelines also prefer the avoidance of organic solvents in pharmaceutical dosage preparations considering products safety profile.

1.3.4. Aqueous Film Coating[10]

Aqueous-based coatings have been increasingly used compared with organic-based coatings. The alteration from organic solvent-based coating to aqueous based coating makes the coating process more cost-effective, though initially it may need a little investment to upgrade the coating facility.

1.3.5. Electrostatic Coating[11-14]

In comparison to organic-based coatings, aqueous-based coatings have become more popular. The coating material contains conductive ionic species of opposite charge is sprayed on the charged substrate. A complete and uniform coating of corners on the substrate is achieved.

There are two kinds of spraying units, based on the charging mechanism a) corona charging and b) tribo charging.

- **Corona Charging:** This is done by the electrical breakdown and then ionization of air by imposing high voltage on a sharp pointed needle like electrode (i.e., charging pin) at the outlet of the gun for the corona charging, the electrical forces are derived from the electrical field between the charging tip of the spray gun and the earthen substance, and from the repulsive forces between the charged particles.
- **Tribo charging:** Unlike corona charging guns, tribo charging uses the friction charging mechanism associated with the dielectric characteristics of solid particles, therefore no free ions or electrical fields are present between the spray gun and the grounded substance. The electrical forces in tribo charging guns are just the repulsive forces between the charged particles.

1.3.6 Magnetically Assisted Impaction Coating (MAIC)[15]

Many dry coating methods have been established such as compression coating, plasticizer dry coating, heat dry coating and electrostatic dry coating. These methods generally allow for the application of high hearing stresses or high impaction forces or exposure to higher temperature to achieve desired coating. The strong mechanical forces and the accompanying heat generated can cause layering and even embedding of the guest particles onto the surface of the host particles. The magnetically assisted impaction coating (MAIC) devices can coat soft organic host and guest particles without causing major changes in the material shape and size.

1.3.7. Vacuum Film Coating[8]

It is new coating method that employs specially designed baffled pan. The pan is hot and water jacketed and it can be sealed to achieve a vacuum system. The tablets are placed in pan and the air in the pan is displaced by nitrogen before the desired vacuum level is obtained. The coating solution is applied through airless spray system. The vapours of the evaporated solvents are removed by vacuum system.

1.3.8. Compression Coating[8]

Compression coating is rarely used, but it has advantages in some cases in which the tablet core cannot tolerate organic solvents or water and yet needs to be coated for taste masking, or to provide delayed or enteric properties to the product. In addition, incompatible ingredients can be conveniently separated by process. This type of coating requires a specialized tablet machine.

1.3.9. Dip Coating[8]

Coating is applied by dipping them into coating fluid the wet tablets are dried in conventional coating pans. Alternate dipping and drying steps may be repeated several times to achieve the coating of desired one.

1.3.10. Enteric coating

This type of coating is given to protect disintegration of tablets inside the stomach pH. Enteric coating material, such as Cellulose Acetate Phthalate, shellac and its derivatives solution are prepared in a volatile solvent. This solution is then coated over the tablets inside the rotating pan. Solvent layer is then evaporated by passing hot air through Tablet bed.

1.4. Equipment Used for Tablet Coating[16,17]

Equipment was usually used to coat the tablet surface with a thin film that acts as a coating material. The general purpose of the film was to prevent the tablet from physical or chemical harm and hide the unpleasant smell, odour, and taste. The coating also shields the tablet from the harsh gastric environment and promotes sustained drug release. The coating also improves the appearance of the tablet.

1.4.1. Classification of Coating Equipment's

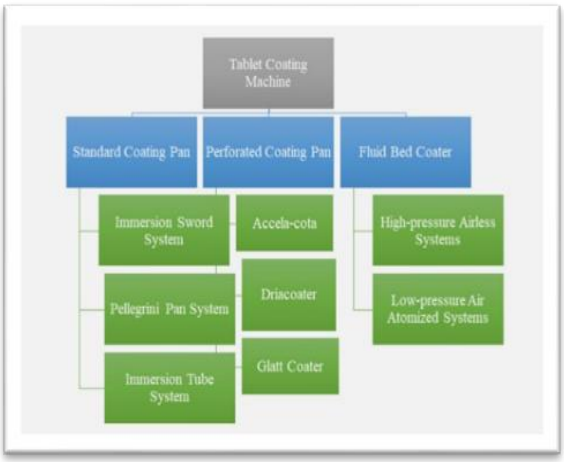

Figure-1: Classification of coating equipment.

Coating Equipment are Categorised into Follow types

1. **Conventional CPN**

- Standard CPN
- Modified CPN
- Immersion sword
- Immersion tube
- Baffled pan with a diffuser (Pellegrini pan)

2. **Perforated CPN[18]**

- Pans rotating on inclined axis: Driacoater
- Pans rotating on the horizontal axis: Glatt Coater
- Pans rotating on the vertical axis: Accela Cota
- Hi-Coater

3. **FBPS (Air Suspension Processors)**

- Top spray
- Bottom spray (Wurster)
- Tangential spray (Rotary)
- Swirling
- Huttlin Kugel coater

1. Standard Coating Pan: These are also called as conventional, traditional, or non-perforated coating pans. They have wide applications for industrial purpose. The standard coating pan is modified in three different ways in order to increase the drying efficiency.

Figure 2: Standard Coating Pan.

Design: This instrument is a pear, circular or hexagonal-shaped container, mounted at the angle of 40-45° on the benchtop. This coating pan has a diameter of 8 to 60 inches (15 to 200 centimetres). This machine is equipped with a motor that provides power for the rotation of the pan on a horizontal axis.

Working Principle: The coating process in a standard coating pan initiates with the loading of tablets. The machine rotation causes the tumbling of tablets around the container. The atomized coating solution is sprayed by nozzles resulting in a uniform distribution of coating materials on tablets. Afterward, heated air is introduced into the pan and passes on the tablet bed causing in drying of the solution.

Advantages

- The coating procedure in a standard coating pan are non-economical.
- These machines are easily cleaned of dust and debris as they do not have perforations.
- Tablets have little chipping and breakage rate in a standard coating pan.
- These pans can easily coat products of any size ranging from mini-tablet or 50-millimeter chewing gum.

Applications Colourful, sugary, and chewable tablets are all because of standard coating pans. Applications of these machines in some industries are mentioned below for your information.

- Food
- Confectionary
- Pharmaceutical
- Nutraceutical

Classification of Standard Coating Pan[18]

The standard coating pan is modified in three different ways in order to improve the drying efficiency. The modifications in the design of conventional coating pan are:

a. Immersion Sword System: This system has a perforated sword-like structure fixed in the table bed for supplying hot air inside the pan. This causes through mixing and effective drying.

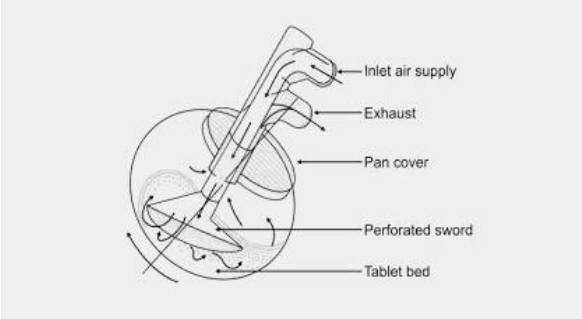

Figure 3: Immersion Sword System.

b. Immersion Tube System: In this machine, a tube is immersed in the pan and has a built-in spray nozzle (located at the top) for distributing both coating solvents and hot air. The hot air moves upward and helps in the drying of the solution.

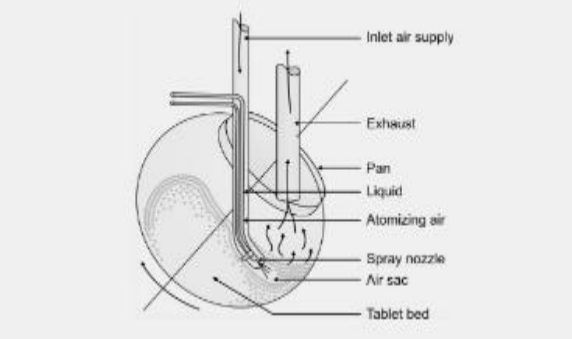

Figure 4: Immersion Tube System.

c. Pellegrini Pan System: Baffle and diffuser are present in the Pellegrini pan system for even circulation of dry air on the tablet bed, which increases rapid drying.

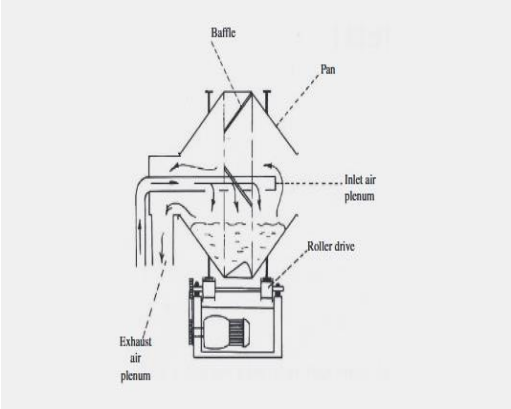

Figure 5: Pellegrini Pan System.

2. Perforated Coating Pan[18]

Now a days Perforated coating pans are the most popular choice of coating devices. These are widely utilized for film coating tablets and pills.

Figure 6: Perforated Coating Pan.

Design: This machine is composed of a fully or partially perforated drum housed in an air tight enclosure. Angled baffles are fixed inside the drum. The movement of these baffles causes tablets to lift and turn.

Working Principle: In a typical perforated pan operation, the spray nozzles are used for coating tablets while the drum is rotating around a horizontal axis. The rotation of drums and baffles is significant in the uniform coating of tablets. The hot air enters the pan from the upper duct and flows diagonally through tablets subsequently vaporizing excess coating solution.

Advantages

- Perforated pans have high drying efficiency thus application of a second coating solution is possible in less time.
- Perforated pans are power-efficient machines.
- These machines perform uniform and even coating in a quick time.
- The balance between incoming and released air does not allow leakage of solvents on tablets beds, thus avoiding the hazardous explosion.

Applications

Perforated pans are high in demand in various industries to improve the appearance and aesthetic of products. Some applications of these machines are:

- Food
- Chemical
- Fertilizer
- Confectionary
- Pharmaceutical
- Cosmetic
- Agriculture

Classification of Perforated Coating Pan: Perforated coating pans come in several designs. Some design examples of these coating pans are:

a. Accela-Cota: Accela-Cota or Hi-coater systems are circular pans, revolving about the horizontal axis with curved perforated sides. The ends of a pan are conical so that tablets get inverted and mixed with the coating solution during rotation.

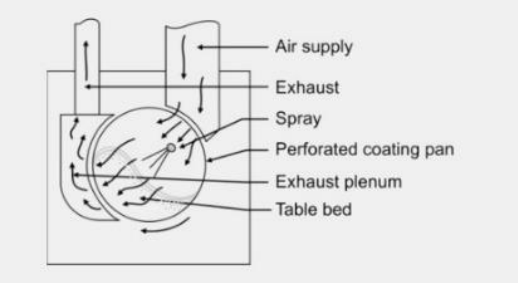

Figure-7: Accela-Cota.

b. Driacoater: Driacoater is equipped with hollow perforated ribs present along the periphery of the rotating pan. When the pan rotates, these ribs go inside the product bed, supply the hot air to the tablet bed and assist in tablet drying. Exhaust air is released from the duct located at the back of the pan.

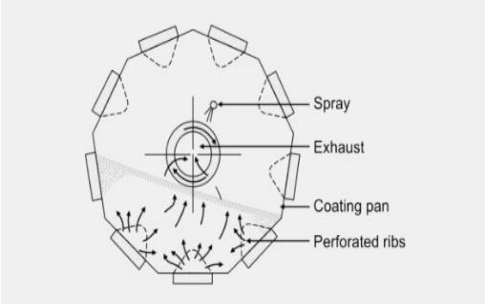

Figure-8: Driacoater.

c. Glatt Coater: Glatt coater is a novel form of a perforated pan, having fully perforated drums for maximum spraying rates in a shorter time. Drying air enters either from inside the pan and goes to the tablet bed or from pan perforation in a reverse manner for incomplete fluidization of tablets. This passage of hot air aids in reducing air turbulence and achieving an ideal coating effect.

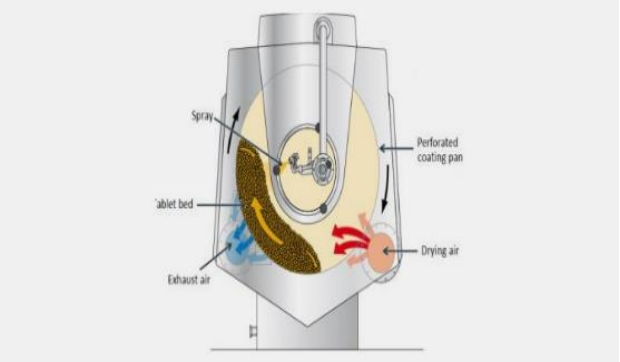

Figure-9: Glatt Coater.

3. Fluid Bed Coater [19-23]

Fluid bed coater or air suspension systems are efficient coating instruments and are used for film coating.

Figure-10: Fluid Bed Coater.

Design: This machine is the vertical chamber in which tablets are suspended and air moves upward. Coating agents are delivered through the spray guns located at the top or bottom of the column.

Working Principle: The incoming hot air moves the suspended tablets upward and outward towards chamber walls and then to the bottom of the column. These tablets then re-enter the stream and the process is repeated several times for a thorough coating of tablets.

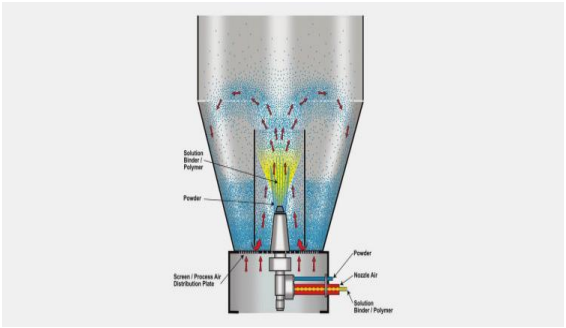

Figure-11: Fluid Bed Coater.

Advantages

- These machines perform efficient coating due to maximum contact between suspended tablets and coating solution.

- These systems are used for multi-particulate tablets.
- Continuous spraying of coating agents in these machines reduces the coating time.
- High recovery rate of organic solvents in fluid bed coating machines.
- There is minimal chance of environmental contamination as every process- from loading to coating is performed in enclosed container.

Applications: Fluid bed coater increase the aesthetic appeal of dietary tablets and boost their Savory taste. These systems have several applications in industries like:

- Pharmaceutical
- Chemical
- Food
- Animal feed
- Confectionary

Classification of Fluid Bed Coater

Fluid bed coater are further classified into three types depending upon spraying techniques.

- Top Spray
- Bottom Spray
- Tangential Spray

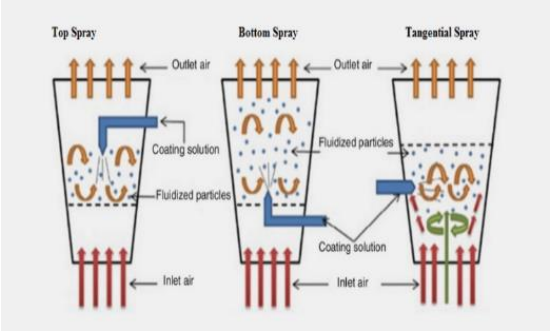

Figure-12: Fluid Bed Coater.

a. **Top Spray:** A top spray is the classical form of fluid bed coaters. They are having spray nozzles fixed in the upper part of the chamber. The purpose is to apply the solution in a downward direction as the fluidizing air is moving upward. Most often a top spray results in an uneven coat thickness. That's why this is not commonly practiced.
b. **Bottom Spray:** Bottom spray arrangement or Wurster is the preferred high-quality of fluid bed coaters as these systems provide a superior quality coating. Unlike a top spray, the spray guns in Wurster's are present in the bottom part of the column. The direction of the spraying solution is the same as of hot air resulting in the similar covering of tablets**.**
c. **Tangential Spray:** Tangential Spray or rotary granulator is the latest innovation in fluid bed technology and is similar to bottom spray apart from the rotation of tablets by means of the rotary disc which are powered by a motor.

1.5. Coated Tablet Evaluation[24]

Determination of the quality of a tablet coat involves studying of the film and the film-tablet interactions. The following test methods can be employed**.**

- Adhesion test with tensile strength testers is used to determine the force needed to peel the film from the tablet surface.
- Diametric crushing strength of the coated tablets is measured by using a tablet hardness tester. The rate of coated tablet disintegration and dissolution should also be studied. Stability studies can be conducted on coated tablets to verify whether temperature and humidity changes would result in film defects.
- Exposure to elevated humidity and measurement of tablet weight gain provide relative information on the protection provided by the film.

1.6. Coating defects[5]

The list of coating defects of Tablets and their possible causes are listed below

- **Picking and sticking:** It is caused by over wetting the tablets, by less drying, or by inferior tablet quality.
- **Capping:** Tablet separates in laminar way. This problem arises from the improper compress ion of Tablet. Tablets became brittle, which promote capping process.
- **Erosion:** If the Tablets are over wetted, soft, drying is not sufficient then the problem of erosion takes place.
- **Peeling and frosting:** Peeling means the removal of coating layer form Tablet surface. It indicates the improper locking in the tablet surface. It may happen due to improper coating solution, over wetting, or Tablet containing high moisture content in it.
- **Chipping:** High rotating speed of pan can lead to Chipping of Tablets, a soft tablet core, or lack of good plasticizer increases this problem many folds.
- **Mottled colour:** Improper preparation or mixing of coating solution can leads to this problem. If the targeted and actual spray rate differ significantly, cold tablet core or improper drying rate also contribute to mottled colour of Tablet.
- **Orange peel:** This refers to a coating texture that resembles the surface of an orange. This occurs due to high spray pressure. Texture of coated Tablet surface became similar like orange surface.

CONCLUSION

Coating of pharmaceutical dosage forms has been developed and aiming to ensure and enhance the quality of tablet dosage form. Different coating techniques were discussed for the coating of dosage form, and each coating technique has its advantages. In addition to that we have discussed evaluation of tablet coating and it defects.

REFERENCES

1. Kamble N. et al. Innovations in tablet coating technology: A review. International Journal of Applied Biology and Pharmaceutical Technology, 2011; 214-218.
2. Lachman Leon et al. The Theory and Practice of Industrial Pharmacy. Second edition, Fourth Indian Reprint, Published by Varghese Publishing house, Bombay, 1991; 346-372.
3. Tech Tips, Aqueous Coating 101. Techceuticals Solutions for Pharma & Nutra Manufacturers since 1989, Cited, 2012 Aug. 05.
4. Behzadi S. Innovations in Coating Technology, Recent Patents on drug Delivery & Formulations, 2008; 209 – 230.
5. M Aulton. Pharmaceutics: The Science of Dosage Form Design, International Student Edition, 304-321; 347-668.
6. A Basu, A De, SS Dey. J Pharma Pharmaceutical Sci., 2013; 2(4): 1-6.
7. G Ankit; B Ajay; K Neetu. International Research Journal of Pharmacy, 2012; 3(9): 48-68.
8. Cole G, Hogan J, Aulton M. Pharmaceutical Coating Technology. Taylor and Francis, London, 1995; 1-5.
9. Thomas M. Solvent film coating, aqueous Vs organic. Midwest Regional Meeting, Academy of Pharmaceutical Sciences. Industrial Pharmaceutical Technology Section, 1978 April 10.
10. Qiao M. et al A Novel Electrostatic Dry Powder Coating Process for Pharmaceutical Dosage Forms: Immediate Release Coatings for Tablets. European J Pharm BioPharma, 2010; 304-310.
11. Pawar A. et al Advances in Pharmaceutical Coatings. International Journal of Chemtech Research, 2010; 733-737.
12. Mazumder M, Sims R, Biris A. Twenty-first century research needs in electrostatic processes applied to research needs in electrostatic processes applied to industry and medicine. Chem Eng Sci., 2006; 61: 2192-2211.
13. Hogan, John E, Page, Trevor R, Linda S, John N. Powder coating composition for electrostatic coating of pharmaceutical substrates. US Patent 6, 406, 738, 2002 June 18.
14. Singh P. et al Estimation of Coating Time in The Magnetically Assisted Impaction Coating Process. Elsevier, 2001; 159-167.
15. Tamhane P.M. Enteric Aqueous Film Coating, Win coat Colours & Coatings Pvt. Ltd., 2011, [Cited 2012 July 17].
16. Knop K., Kleinebudde P. PAT-tools for process control in pharmaceutical film coating applications. Int. J. Pharm, 2013; 457: 527–536.
17. Haaser M., Naelapää K., Gordon K., Pepper M., Rantanen J., Strachan C., Taday P.F., Zeitler A., Rades T. Evaluating the effect of coating equipment on tablet film quality using terahertz pulsed imaging. Eur. J. Pharm. BioPharma, 2013; 85: 1095–1102.
18. Saikh MAA: Pharmaceutical's coating. LAP Lambert Academic Publishing Germany, 2015.
19. Liu R, Li L, Yin W, Xu D and Zang H: Near-infrared spectroscopy monitoring and control of the fluidized bed granulation and coating processes-A review. International Journal of Pharmaceutics, 2017; 530(1-2): 308-315.
20. Mandić J, Luštrik M, Vrečer F, Gašperlin M and Zvonar Pobirk A: Solidification of carvedilol loaded SMEDDS by swirling fluidized bed pellet coating. International Journal of Pharmaceutics, 2019; 566: 89-100.
21. Santos Silva B, Colbert MJ, Santangelo M, Bartlett JA, Lapointe-Garant PP, Simard JS and Gosselin R: Monitoring microsphere coating processes using PAT tools in a bench scale fluid bed. European Journal of Pharmaceutical Sciences, 2019; 135: 12-21.
22. Mandić J, Pirnat V, Luštrik M, German Ilić I, Vrečer F, Gašperlin M and Zvonar Pobirk A: Solidification of SMEDDS by fluid bed granulation and manufacturing of fast drug release tablets. International Journal of Pharmaceutics, 2020; 583: 119377.
23. Mohylyuk V, Patel K, Scott N, Richardson C, Murnane D and Liu F: Wurster fluidised bed coating of micro particles: towards scalable production of oral sustained release liquid medicines for patients with swallowing difficulties. AAPS Pharm Sci Tech, 2019; 21(1).
24. Rowe RC. Acta Pharm Technol, 1983; 29: 205.