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Review Article

A Brief Review on Tablet Coating

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ABSTRACT

A tablet or granule for API is coated using pharmaceutical technology with a thin polymer-based film. It has the benefit of disguising the drug's taste, odor, and color.It generates physical, chemical, and gastrointestinal environment protection for the medication In pharmaceutical dosage forms, coating is an important element that affects bioavailability, shelf life, and drug release. Different coating methods are applied to solid dosage forms to enhance their performance, such as enteric coating, film coating, and sugar coating. Getting over the limitations of solvent-based coating is the key goal of the most recent developments in tablet coating. This article discusses the history of coating, coating methods, coating types, coating materials, coating techniques, coating equipment, and coating defects.

INTRODUCTION

An illustration of a unit dosage form is a tablet. It crushed to give it the right shape after the active ingredients and another additive are mixed together. This is a compressed version of the drug. Units of measurement required for solid measure formulations in prescription medications Tablets, capsules that are transparent ,pellets, packets, powdered substances, dry substance inhalers, and consumable forms are examples of solid dosage forms. This category includes unit doses of a few medications. Excipients are frequently added to formulations as binders, glidants, sweeteners, and other materials.1 The aim of adding an external coating layer to a nearly dry dosage form is to supply specific advantages. These benefits might vary from making it easier to identify the product to altering the way the medicine is released from the dosage form. A excellent tablet needs to be coated frequently after being made. Many oral solid dosage forms, including capsules, tablets, multi-particulates, and drug crystals, can be covered. A tasty polymeric film involves the tablet surfaces when a batch of tablets are set in a coating pan and a coating mixture is added. The coating on the pan surface transitions from a sticking liquid to a sticky semisolid and then cools to a non-adhesive dry state before the tablet surface totally dries. 2-4

OBJECTIVES OF TABLET COATING :

The following are the goals of tablet coating:

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To improve patient compliance while disguising the unpleasant taste, color, or smell of the medication.

To provide the medicine with chemical and/or physical protection and shield it from the outside increase stability.

- Prolong the drug's shelf life
- Make large dose forms easier to swallow.
- To postpone volatile ingredient loss.
- Some cases of repeat-action, sustained-release, and delayed-release (enteric coated) medicines, to alter and/or regulate the rate of drug release.
- To combine medications that are incompatible in a single dosage form.
- Strengthening the dose form mechanically . Improving the appearance of the medication and implementing distinctive colors to facilitate easier identification for patients, pharmacists, and manufacturers alike."5-7

Advantages

1. Tablets stand out as unit dosage forms due to their extensive range of functions, minimal content variation, and superior dose accuracy, particularly when compared to other oral dosage forms.
2. They produce the best packing and strips at the lowest cost.
3. Low cost.
4. More compact and lighter.
5. Preserving ideal chemical and microbial balance during oral administration
6. Effective in large-scale manufacturing.
7. Low hang-up potential and easy to swallow.
8. Harsh tastes and unpleasant scents can be covered up with coating.
9. A product can be gradually launched thanks to enteric coating.
10. Easy to manage 8

Disadvantages

1. Children or the unconscious may have difficulty swallowing.
2. Some medications are resistant to compaction into dense compacts because of their amorphous and low density properties.
3. It might be required to encapsulate or coat medications when testing those that are harsh-smelling, sour, or oxygen-sensitive. In this case, capsules might be the best value.9

Historiography of Coating :

The term "panning" was eventually the only one used to refer to coating a tablet. In the candy business, "panning" is still a commonly used term. Traditionally, a rotating drum on a work surface was utilized for coating. A coating mixture was introduced, and the tablet mattress was covered with the solution as the pan turned. The length of time it took for the coating process to dry was this technology's primary drawback. The solution was to allow it to dry uniformly. When film coating first became popular, a punctured pan was utilized for spraying thin membrane that typically made up 1% to 3% of the tablet's overall weight. The tablets were able to dry faster by using holes in the pan to allow heated or cooled handled air to be drawn through it, much like in a clothes drier. This cut down on the total method time. With the invention of walked toward drying, the possibility to change the film coating fluid from a solvent-based substitute into water-based among emerged. 10-13

Coating process :

Coating is frequently done on rotating coating pans. The pan is filled with uncoated tablets, and when the pills tumble, the liquid coating ingredient is poured into the pan. Air is blown over the spinning tablets to cause the liquid coating material to evaporate, leaving the solid coating material layer behind. The coating process typically uses the next

steps:

- The identification of the batch and the coating type choice.(A sugar or film coating)

- Dispensing (exactly dosing all necessary raw materials)
- Inserting pills into a pan.
- Warming up the pills
- Spraying (when the coating material is applied while the tablet is rolled at the same time)
- Dried
- Reducing
- Discharging 14–15

Types of Coating

- Film Coating.
- Sugar Coating.
- Enteric Coating
- Controlled Release Coating.
- Specialized Coating.

a Compressed Coating.
b Electrostatic Coating.
c Dip Coating.
d Vacuum Coating.

Film Coating

According to a study, the sugar-coating procedure takes a long time .Thus, film coating technology has taken the role of this technique, which involves applying a spray in the solvent over a tablet's surface to create a thin, homogeneous film. There are two different methods for coating films. There are various polymer utilized in these coating, including vinyl polymer, silicones, polysaccharides, cellulose ethers, and polymers. Whereas non-aqueous coating on films frequently employs an organic solvent, aqueous film covering applies water as its solvent of choice. Organic solvent film coating The most often used technique for applying liquid coating to solid dosage forms is to dissolve a blend of polymer in an organic solution. After that, a pan coater is used to spray the substance onto the dosage form, and it gets heated to create a coating.

Aqueous film coating

Water-based coating is used more often than organic based coating. Water-based solvents must replace organic solvents due to their limitations. Its coating process involves less facility modification and is more economical. Method for Film Coating Procedure When film coating, a batch of tablets is sprayed with the coating composition on a rotating platform, and the solvent is then evaporated using warm air. Business-wise, the solvent is applied via spray-atomization, whereby the polymer dissolves in an aqueous solvent and disperses into tiny droplets that are applied to the surface of the subtractor that has been warmed. Surface dissolution and physical mixing are then carried out at the film-forming surface if the solvent gets within the core.

Mechanisms of Film Formation

After going through several stages of film development, When the polymer mixture is put on to the tablet's surface, cohesiveness forces cause the covered polymer molecules to adhere to one another. To achieve high cohesion, the film material's continuous surface must coalesce and the polymer molecules' cohesive strength must be relatively strong.The coating of neighboring polymer molecular surfaces or layers is caused by diffusion. The individual polymer chains align as the solution's viscosity rises, if there is sufficient binding force between the particles, as well as sufficient dispersion and coalescence over the more thorough transpiration of water, the molecules will remain close to one a different and deposit on above a previous polymer layer.16-18

Sugar coating :

Compressed tablets could have a sugar layer that is colorful or plain. After being swallowed, the coating soon dissolves because it is water soluble. The sugar layer serves as a barrier to unfavorable taste and order while shielding the medicine inside from the outside environment. The sugar layer also improves the compressed tablet's look and makes it possible to imprint the manufacturer's identification. A mixture of insulation, flavor masking, tablet core smoothing, coloring, and

modified release are all provided by in these coating.

The sugar coating process typically consists of five steps:

- **Sealing :**

Produces barrier to moisture and hardens the tablet's covering.The tablet edges are quickly rounded off by the subcoating process.

- **Grossing/Smoothing:**

Expands tablet size to predetermined dimension and smooths out the subcoated surface.

- Coloring determines the tablet's color and final dimensions.
- **Polishing:**

Creates the gloss-producing properties.

- **Sealing -**

In order to reduce attritional effects, the seal coat hardens the tablet's surface and creates a moisture barrier. It is probable that during the first sugar coating stage, core tablets with extraordinarily fast rates of collapse could begin to crumble. Sealants, which are composed of insoluble in water polyethylene and film formers, are typically supplied from a chemical solvent solution. Since extremely porous tablets are likely to soak up the initial layer of solution, stopping it from passing evenly through the surface each tablet in the batch, the amount of coating provided as a sealing coat will primarily depend on the porosity of the tablets. As a result, more resin solution applications may be necessary to ensure that the tablet cores are properly sealed.solvents include Zine, Shellac, Polyvinylacetate Phthalate, Hydroxylpropylcellulose or methylcellulose , CAP etc.

- **Subcoating -**

The sugar coating process actually begins with subcoating, which allows for the quick accumulation required for coating. Additionally, it serves as a base for the smoothing and color coatings.

- **Grossing -**

The grossing procedure is meant to accurately file and soft the surface defects that was made during the subcoating process. Additionally, it enlarges the tablet to a predetermined size. Using a syrup with dissolved solids will speed up the buildup and enhance the filling properties if the subcoating is fine and has many flaws. Generally, things will smooth out if you use a simple syrup solution, which contains roughly 60–70% sugar solids.Typically, this syrup includes acacia, starch, gelatin, colors, and opacifiers if needed. Tints of the desired color can be added with small amounts of color suspension when coating flaws are present.

- **Color coating -**

This step is usually essential to the success of sugar coating and involves repeatedly applying a syrup solution (50–70% sugar solid) that contained the necessary coloring agent.Soluble dyes are typically employed in the coating process to produce the desired color because they travel to the outer layer during the drying process. However, soluble colors are no longer used in the coating of pharmaceutical tablets because insoluble certified lakes have replaced them. Color coating works best when a pre-dispersed opacified lake suspension is used.

- **Polishing -**

To attain a final elegance, sugar-coated tablets must be polished. Wax mixtures such as beeswax, carnuba , candelila or hard paraffin wax are used to polish objects by being applied to tablets in a polishing pan.19

ENTERIC COATING

The location in the digestive tract where the pill is absorbed is controlled by an enteric coating. Since the word "enteric" refers to the tiny intestine, enteric coatings prevent medication from releasing before it reaches the intestine. At low pH levels, the enteric coated plastics continue to unite, rendering them insoluble.Nevertheless, a polymer expands or dissolves in the fluid in the GIT as the

pH rises because the acidic functional groups become ionisable. Materials for enteric coatings include fatty acids, waxes, polymers, CAP, CAT, PVAP, HPMCP, fibers of plants .There are some justifications on a coating capsule or tablet component in this manner:

- Protection of active medicinal components (such as enzymes and some antibiotics) from the acidic environment of the stomach.
- To stop nausea or gastrointestinal distress brought on by an irritant in a medication (such as sodium salicylate).
- To deliver medications in their most concentrated form to the principal site of absorption in the small intestine, where absorption is most effective.
- To give repetitive action a delayed-release component.
- Important for reducing medication first pass metabolism.

Regulating the pH mobility profile of the enteric coated solution requires careful consideration of both the paint layer thickness and the polymer selection. Enteric coatings are generally available for the most frequently used drugs that cause stomach ulcers, such as aspirin, diclofenac, and naproxen. The medication omeprazole, which inhibits the creation of stomach acid, is typically enclosed in an enteric coating. This coating can be in the form of capsules or dispersible granules. This is because omeprazole is broken down in acid. Sulfasalazine is used to treat intestinal inflammation known as Crohn's disease in addition to arthritis. It is usually administered with an enteric coating when used for Crohn's disease, as it needs to be absorbed in the intestines to function; however, when used for arthritis, it is frequently administered without in enteric coating to allow for rapid absorption . Erythromycin base is contained in a specially enteric-coated tablet in the antibacterial medication ERY-TAB, which helps the antibiotic be absorbed effectively in the small intestine and shields it from the eliminating effects of stomach acidity. Erythromycin delayed-release tablets, or ERY-TABs, come in dosage abilities ranging from 250 mg to 500 mg. The free base of each white oval tablet shields the antibiotic from the eliminating effects of stomach acids and promotes effective absorption of the medication in the small intestine. Each white oval tablet of the erythromycin delayed-release tablets contains varying dosage strengths of erythromycin as the free base, ranging from 250 mg to 333 mg to 500 mg.Enteric coated aspirin is another tablet that is offered for sale. For instance, enteric-coated peppermint oil and Micropirin® 75 mg EC tablets. For instance, Colpermin®2.1 has the ideal enteric coating material characteristics.

- Susceptibility/permeability to intestinal fluid;
- Resistance to gastric fluids;
- Connectivity with the drug substrate and most of the ingredients in the coating solution
- Creation of an ongoing film
- Affordable, non-toxic, and easy to use
- Capacity to print easily

HOW ENTERIC COATING WORKS

Three layers make up time release press coated ETP tablets: a drug-containing core tablet (for quick release), a press-coated swellable hydrophobic polymer layer (for time release function), and an enteric coating layer (for acid resistance function).The tablet fails to distribute the drugs in the stomach because of the resistance of the outer layer of the enteric coating to acid. Following gastric emptying, the intestinal fluid causes the press-coated polymer (HPC) layer to gradually deteriorate while the enteric coating layer quickly disintegrates. Since there is no drug release period (lag phase) following gastric emptying, rapid drug release happens when the damaged front reaches the core tablet, which takes some time.The weight or makeup of the polymer determines how long the drug release interval.20-21

ADVANCSED TECHNIQUES IN TABLET COATING :-

ELECTROSTATIC COATING:

The first electrostatic dry powder coating method for tablets was developed using a pan coater system and electrostatic dry powder coating (Figure 1). To produce tablets with a smooth surface, excellent coating consistency, and a release profile that resembles tablet cores, an improved dry powder coating technique is employed. In the pharmaceutical industry, an innovative replacement for solvent- or aqueous-based coating processes is the use of electrostatic dry powder coating technology.

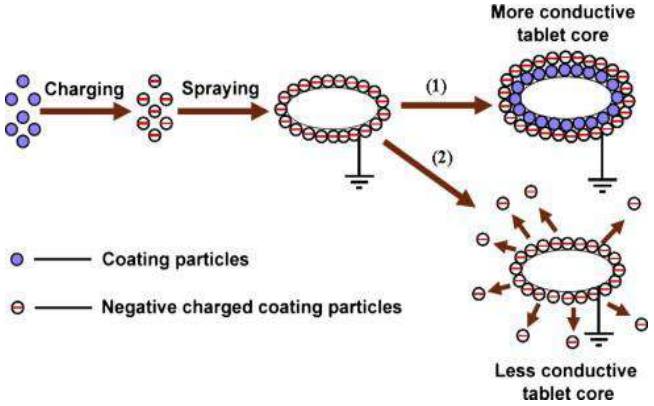


Figure 1. Electrostatic Coating System

The food industry, paint technologies, metal coating, and living cells are just a few of the many industries that use the electrostatic coating technique. This process eliminates the need for a solvent by spraying a blend of polymers and finely ground particles onto a substrate. Subsequently, the powder mixture fuses into a film when the substrate is baked to cure it. Depending on the charging mechanism, spraying units come in two different varieties:

a) Tribio charging
b) Corona charging.31-32

Magnetically Assisted Impaction Coating :

Dry coating methods such as compression coating and electrostatic dry coating produce heat as a result of strong mechanical forces.In the presence of a magnetic field, it act as fluidized bed system. Mechanism: The stages of the MAIC process are described below. (Figure)

Stage I:

Magnetic particles first leave the system.

Stage II:

Disintegration of visiting particles or covering materials.

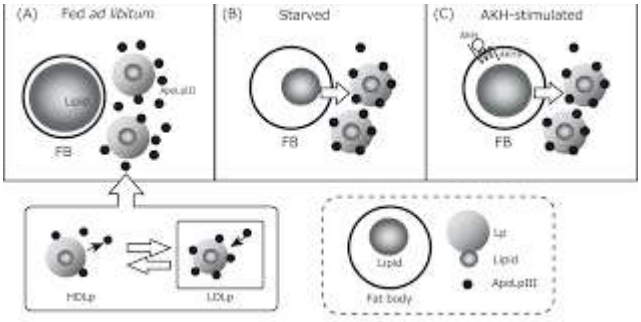


Figure 2 : shows how the MAIC approach handles coating.

Stage III:

Magnetic store wall interaction with particles.

Stage IV:

The coating's constituent parts and the particles communicate.

Dip coating:

The method for coating tablets is to dip them into the coating fluid and then immediately drizzle them with the coating pan. After letting the coat dry, the coated tablet is polished and the coat is stabilized.

Compression coating:

Although rare, this kind of coating process is used when the tablet core is not able to withstand organic or aqueous solvents.

Vacuum film coating:

This method makes use of a baffled pan that has been particularly created. Vapor from solvents is removed using the vacuum system.

Supercell coating technology

This method effectively coats hygroscopic or friable tablets by precisely controlling the deposition of coating ingredients on the tablet layer. To avoid "twinning," the adhesion of two or more tablets, this operation is continued slowly.

Super cell coating technology has the following features;

- Constant coating
- Quick processing
- Modular structure that is adaptable
- No scaling up of parameters is present.
- R&D batch size (at least 30 grams each batch).
- Technology advancement
- Multilayered covering
- Complicated coating shapes
- Floppy tablets
- Technology enablers.

Pure metals like tantalum, copper, and aluminum as well as blended coatings like al-al2o3 are commonly deposited using cold spray coating with laser assistance. 33-35

Coating Material:

Nonenteric material:

Not all polymers that have been considered for film coating can be mentioned. The discussion that follows is meant to serve as a guide for students and pharmaceutical scientists, describing only some of the information that is most frequently used by the pharmaceutical business. Examples: Sodium carboxymethyl cellulose, polyethylene glycols, acrylic polymer, hydroxypropyl methyl cellulose, hydroxyethyl cellulose, ethyl cellulose, and hydroxypropyl cellulose are among the materials.

Enteric material:

More than a century has passed since enteric coating was first used on pills and compressed tablets 36. The following are some of the most significant causes of enteric coating:

1. To shield medications that are sensitive to stomach acid, such as enzymes and some antibiotics.
2. To avoid nausea or gastrointestinal distress brought on by a medication that has irritated the stomach, like sodium salicylate
3. For example, concentrated forms of intestinal antiseptics can be delivered directly to the intended site, avoiding the stomach's systemic absorption. This makes it possible to administer drugs made especially to act locally in the intestine.
4. To transfer medicines in their most concentrated form to the main site of absorption after they are best absorption in small intestine.
5. To provide repeat-action tablets a component with a delayed release.

The following characteristics are necessary for a perfect enteric coating material:

1. Gastric fluid resistance.
2. Easily exposed to or permeable to digestive fluids.
3. The majority of coating solution ingredients and the drug substrates are compatible.
4. Individual and coating solution stability. The movies shouldn't change as they become older.
5. Creation of an ongoing film .
6. Lack of toxicity
7. Affordable
8. Simple application without the need for specialized tools.
9. The ability to easily print or allow the application of film to debossed tablets A variety of materials are available for pharmaceutical formulations to use for creating enteric coating granule, pellet, or tablet products.

Examples :

Acrylate polymers, 3 types of phenolphthalates are hydroxypropyl methylcellulose, polyvinyl acetate, and cellulose acetate..36

Solvent:

The polymers and other additives are dissolved or dispersed in solvents, which are then applied to the substrate surface.

Ideal conditions

- Should be a polymer system that dissolves or disperses
- Other additives should mix into the solvent solution with ease.
- Low polymer concentrations (2–10%) shouldn't be used in excessively viscous fluids processing issues brought on by the solution system
- Should be affordable, inert, tasteless, odorless, nontoxic, and combustible
- Rapid drying rate
- Environmental contamination is absent

The majority of the time, solvents are employed either by themselves or in conjunction with other substances such water, acetone, methylene chloride, isopropanol, ethanol, and methanol. Due to lack of environmental and financial concerns, more water is consumed.Non aqueous solvents are utilized for medications that quickly hydrolyze in the presence of water.

Plasticizers :

For the desired outcome, a combination of plasticizers may be utilized. With regard to the polymer being plasticized, the plasticizer concentration is specified. The recommended range for plasticizer percentages by weight of the film former is usually 1% to 50%. Plasticizers include castor oil, glycerin, PEG, lower molecular weight (200–400 series), and surfactants that are frequently used. PEG and PG are more commonly used in aqueous coatings, but castor oil and spans are frequently used in coating solutions based on organic solvents. It is imperative that the solvent solution utilized to dissolve the external plasticizer and film-forming material is soluble in both. The plasticizer and the film former ought to demonstrate a certain level of solubility.22

Colorants :

The US FDA defines a color additive as any material, including pigments, dyes, or other compounds that can add color to food, medications, beauty products, or the body of a person.In the pharmaceutical industry, the main function of colorants or coloring compounds is to provide pharmaceutical dosage forms or drugs a distinctive appearance. It would not be inaccurate to refer to pharmaceutical colorants as cosmetics given that using the proper pharmaceutical colorants might enhance the visual appearance of certain dosage forms. Most colors have universal associations across a wide range of cultures, with red frequently being associated with vigor and activity and blue and green with tranquility and patience. Patient adherence: Many patients use color to distinguish the prescribed drug and the appropriate dosage. The improvement of patient compliance with colored medicine is an important consideration.B. Identification: Products belonging to the same product line or product lines from other manufacturers that have similar appearances can be distinguished by their colors 23–25.

Opaquant-Extenders :

These fine inorganic powders are employed to enhance film coverage and introduce a broader range of pastel hues . These inorganic components offer a white coating or conceal the tablet's basic hue. Colorants must be used in larger concentrations and are quite expensive. These inorganic substances are affordable. The quantity of colorants need decreases when these inorganic components are present. Titanium dioxide, oxides (such as magnesium oxide), hydroxides (such as aluminum hydroxides), carbonates (such as magnesium carbonates), and silicates (such as talc and aluminum silicates) are the materials that are

utilized the most frequently. It was found after looking into the pigments used to create opaque films that they have useful concealing of intagliation.

Miscellaneous coating solution component :

The coating solutions may contain tastes, sweeteners, surfactants, antibacterial agents and antioxidants, etc.22

Equipments used in tablet coating :

Three types of equipments in tablet coating

A. Conventional Pan Systems

a) Pellegrini system
b) Immersion-sword system
c) Immersion –tube system

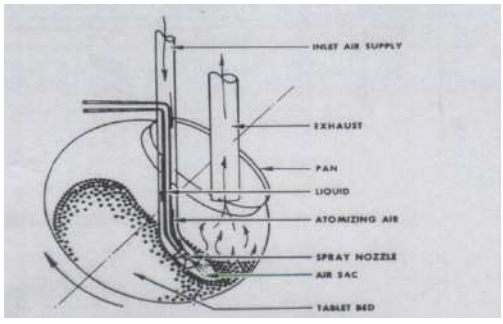
B. Perforated Pans System

a) Accela-coata
b) Hi-coater systems
c) Driacoater
d) Glatt coater

C. Fluid Bed System

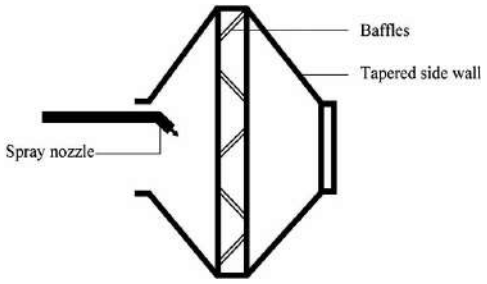
A. Conventional pan systems:

The standard coating pan system consists of an annular metal pan that is angled slightly on a stand. The pan, having a diameter ranging from 8 to 60 inches, is rotated around its center horizontally by a motor. Air ducts at the top of the pan are used to transfer heated air into the pan and on the tablet bed surface.



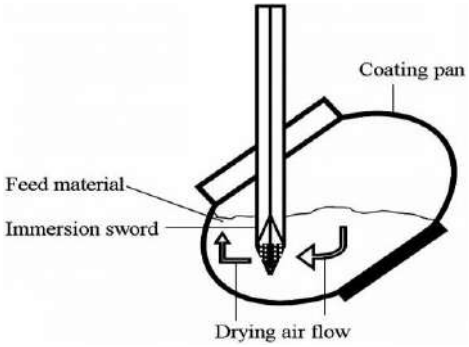
a. Pellegrini pan:

It is enclosed, mechanized, and equipped with a baffled pan to distribute drying air evenly.



b. Immersion-sword system:

- A metal sword with holes that is submerged in the tablet bed is used to introduce drying air.
- Through the bed, drying air rises.
- The coating solutions are applied to the tablet bed surface using an atomized spray system

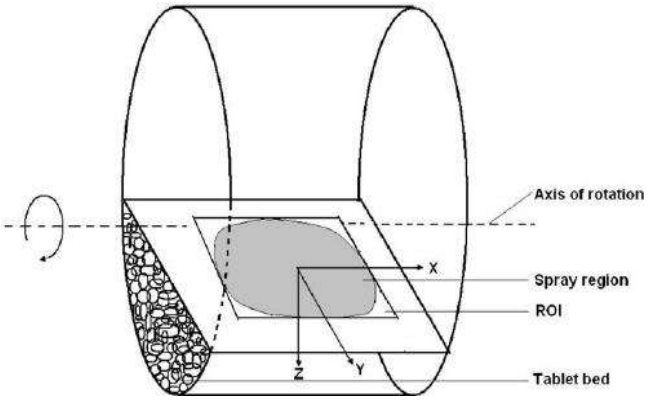


c. Immersion-tube system:

Heated air is supplied through a submerged tube, while the coating solution is administered through a spray nozzle integrated into the tube's tip. Using the tablet bed, the drying air rises and is released via a traditional duct.

B. Perforated pan :

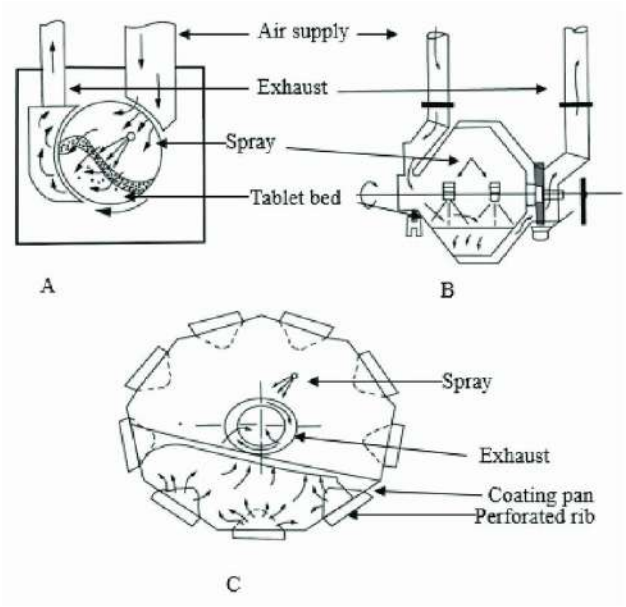
An enclosed housing contains a perforated or partially holed drum that revolves on its horizontal axis.



a. Accela-Coata

b. b. Hi-coater:

Drying air is pushed into the drum, travels via the bed, and then exits the drum through openings.



c. Driacoater :

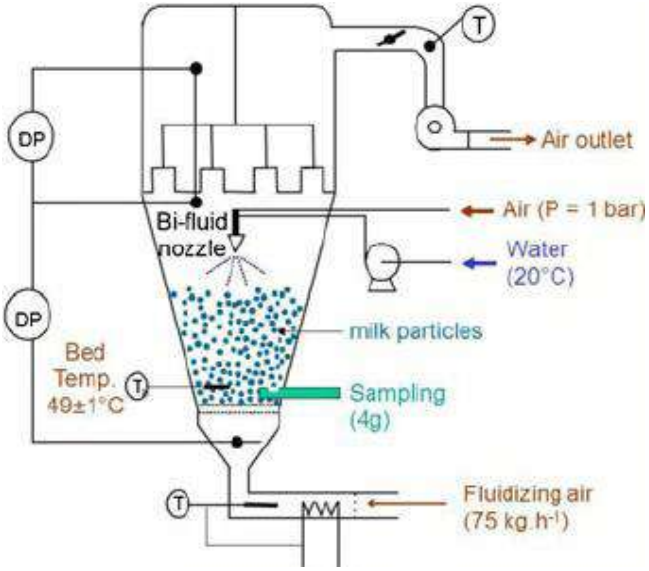
introduces drying air through hollow ribs that are perforated around the entire perimeter of the drum. The coating pan revolves when the ribs settle into the tablet bed.The tablet bed becomes fluidized as drying air rises through it. Exhaust comes from the pan's back.

d. **Glatt coater :**

- An exhaust duct leads drying air from the drum's interior out through the tablet bed.
- It has a permitted split-chambered plenum that allows drying air to be sent up via the drum openings in the opposite direction, partially fluidizing the tablet bed.
- There are a lot of possible air flow patterns.

C. Fluidized bed :

- This drying system works very well.
- •As drying air rises, the tablet sleep in a horizontal chamber becomes more fluid. The tablets need to rise at this location because the airflow is changed to push more air through the center of the column.
- The tablets are escorted upward using the chamber's middle.
- •Coating solutions are always sprayed onto the cascading tablet bed using a spray nozzle located at the bottom of the chamber or nozzles located in the upper portion of the chamber. Subsequently, the solutions travel towards the chamber wall and go down to rejoin the air flow at the chamber's base.26-28



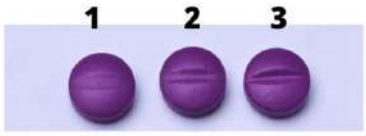
Tablet Caoting defects :

Picking and sticking:

When the coating separates the tablet's core from the outer coating, this phenomenon takes place. Insufficient drying, too much moisture, or poor tablet quality are some of the causes.

Bridging:

This is often caused by over-applying the coating, using an insufficient tablet embossing design, using an excessively thick coating, using the wrong atomizing pressure, or having an excessive amount of solids in the mixture. It happens when the tablet's text is filled in by the coating.



1 shows Logo Bridging compared to 2 and 3

Erosion:

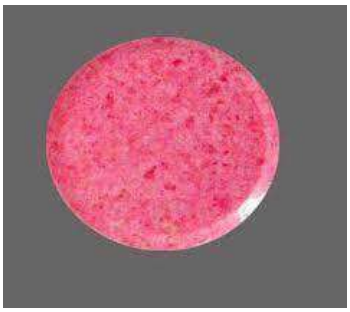
It is caused due to weak tablet surfaces, overly wet tablet surfaces, insufficient drying, or soft tablets.

Twinning:

Two tablets that adhere to one another are referred to by this name, and capsule-shaped tablets are frequently affected by it.

Mottled color:

Inaccurate production of the coating solution prevents the target spray rate from being reached, This can happen if the coating dries too quickly or if the tablet cores in a cold.



CONCLUSION:

One key method in the production of various dosage forms is tablet coating. It aids in enhancing the medications' stability, shelf life, and bioavailability. Patient compliance is increased by coating the dose form. This overview discusses historeography of the coating, coating methods, various types of coating, advancement in coating, coating materials, advantages, and coating goals.29-30

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