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Review Article

A Review on Microencapsulation

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ABSTRACT

The review of microencapsulation encloses the applications, methods of the preparation the microcapsules and their evaluation. Micro encapsulation is the process of surrounding or enveloping one substance within another substance on a very small scale, yielding capsules ranging from less than one micron to several hundreds of microns in size. Micro encapsulation refers to a phenomenon in which drug compounds are safely encapsulated as a small capsule in order to achieve most stable product. This technology brings a huge impact in the area of pharmaceutical research which also offers special appearance in controlled and target drug delivery systems. The article is a review of classification of microcapsules, drug release mechanism from microcapsules, materials used for microencapsulation, applications of techniques involved in the preparation of microcapsules and evaluation of microcapsules.

Keywords: microencapsulation, Polymeric drug delivery devices, drug release mechanism

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CLASSIFICATION

These are classified into three basic categories. They are

- Mononuclear
- Polynuclear
- Matrix

Mononuclear microcapsules contain the shell around core, while polynuclear capsules have many cores enclosed within the shell. In matrix encapsulation, the core material is distributed homogenously into the shell material.[6,7,8,9,10.]

TYPES OF DRUG RELEASE MECHANISM: -

Dissolution control system
-encapsulation
-matrix
Diffusion control system
-reservoir
-matrix
Dissolution and diffusion control system
Water penetration control system
-swelling control
-osmotically control
Chemically control system
-erodible
-drug covalently linked polymer Hydrogel[11,12.]

Dissolution control system:

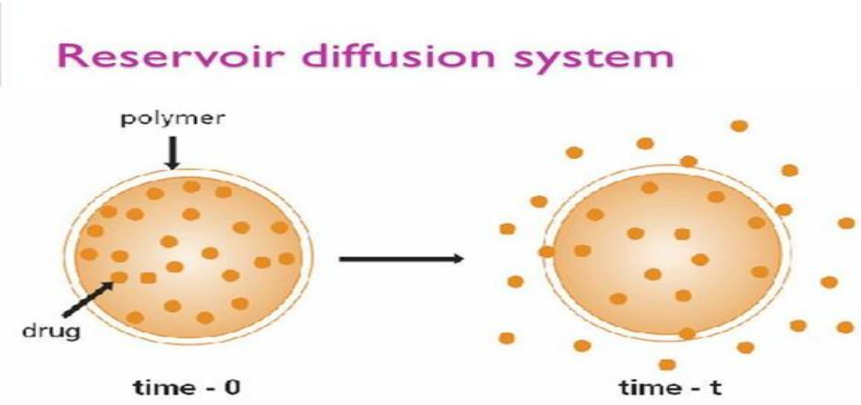
In this system the rate controlling step is dissolution. The drug is embedded in slow dissolving or erodible matrix or by coating with slow dissolving substances. It is of two types

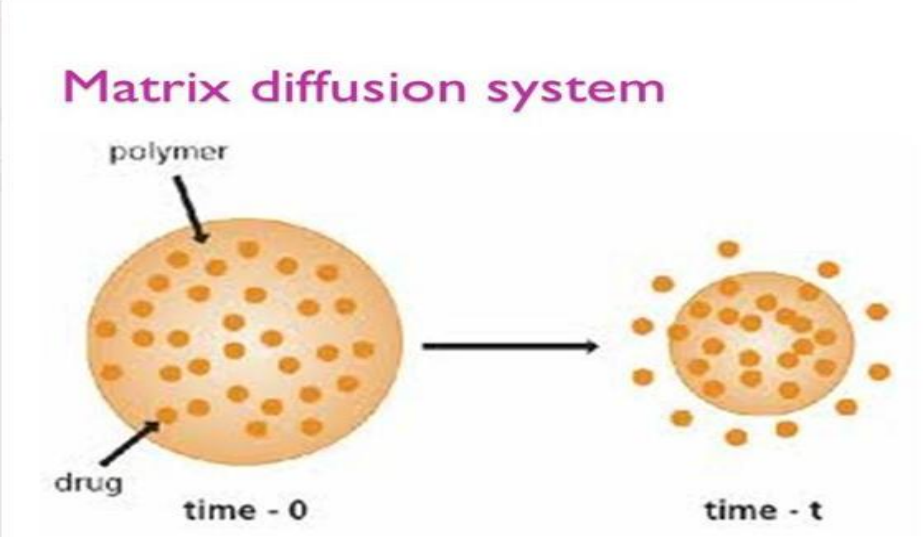
Encapsulation: The drug particle is coated or encapsulated by micro encapsulation techniques with slow dissolving materials like cellulose. The dissolution rate depends upon the solubility and thickness of coating.

Matrix: It is also called as "MONOLITHS". They employ waxes such as bees wax, hydrogenated castor oil which control drug dissolution by controlling rate of dissolution fluid penetration into matrix.[13,14,15,16.]

Diffusion control system:

The rate limiting step is diffusion of drug through inert water insoluble membrane barrier. These are of two types





[17,18,19,20.]

Water penetration control system:

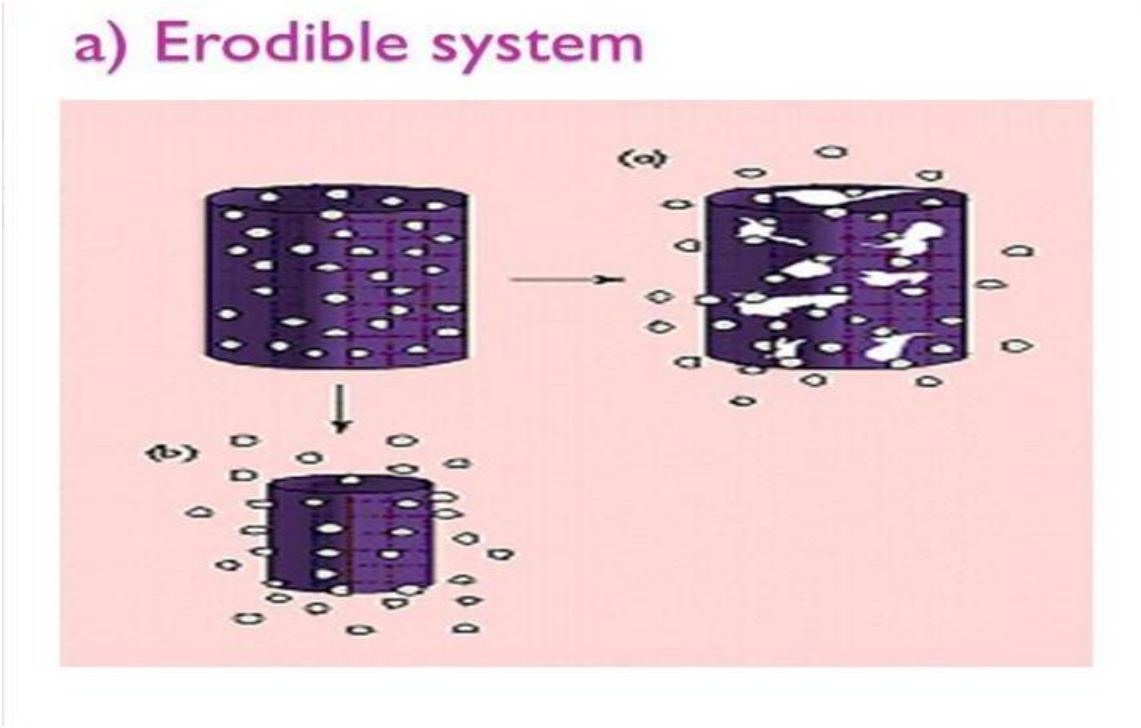
Rate controlling step is penetration of water into the system. It is of two types

Swelling control system: These types of systems are initially dry and when placed in body, absorb water or other fluids and it swells. Swelling increases aqueous solvent content within the formulation as well as the polymer mesh size.

Osmotically control system: In this type of system core i.e., osmotically active drug or combination of osmotically inactive drug + osmogene is enclosed within semi permeable membrane made up of biocompatible polymer like cellulose acetate.[21,22,23,34]

Chemically control system:

In this type the polymer is degraded as a result of hydrolysis into biologically safe and smaller moieties. It is of two types



Pendent: It consists of linear or homo copolymers attached to the drug. The drug is released from polymer by hydrolysis or enzymatic degradation of the linkage[25,26,27,28.]

Hydrogels:

- Hydrogels are water swollen 3-D structure composed of primarily hydrophilic polymers.
- They are rendered insoluble because of physical or chemical cross links.
- The physical cross links include crystallites, entanglements, weak association like hydrogen bonds.
- It provides desirable protection to labile drugs, proteins and peptides.[29,30,31,32]

APPLICATIONS OF MICRO ENCAPSULATION: -

- This technique has been widely used for masking the organoleptic properties like taste and odour of many drugs.
- By using micro encapsulation techniques, the liquid drugs can be converted into a free-flowing powder.
- The drugs can be protected which are sensitive to moisture, light and oxygen. e.g.: Nifedipine
- It is helpful to prevent the incompatibility between the drugs.
- The drugs which are volatile in nature may vaporize at room temperature like Aspirin and Peppermint oil can be prevented by micro encapsulation.
- This is employed to change the site of absorption.
- It is also employed to prepare intra uterine contraceptive devices.
- It is used for sustain release or prolonged action of drug.
- Manufacturing of powders and suspensions.
- Immobilization of microbes and microorganisms to prevent oxidative degradation.
- To separate incompatible substances.
- Protection of gastro intestinal tract.
- For proper drug delivery.
- It is used in genetic engineering.[33,34,35,36,37,38.]

Materials Used for Micro Encapsulation: -

It includes

CORE MATERIAL:

It is defined as the specific material to be coated, which can be either liquid or solid. The composition of core material can be varied as the liquid core includes dispersed or dissolved material. The solid core material may be a combination of active ingredients, stabilizers, diluents, excipients.

COATING MATERIAL:

The inert material that surrounds the core material and is used to form a protective polymer film around each individual drug particle.

Classification of coating materials-

Water soluble resins
- -Gelatin
- -Starch
- -Hydroxy ethyl cellulose

Water insoluble resins
- -Ethyl cellulose
- -Polyethylene
- -Polyamide
- -Poly methyl acrylate

Waxes and lipids
- -Bees wax
- -Stearic acid
- -Steryl alcohol

Enteric resins
- -Shellac
- -Zein
- -Cellulose acetate phthalate

VEHICLE: It is used for dissolving coating material. It is used for dissolving the coating materials.

Aqueous vehicle
- -Water

Non- aqueous vehicle
- -Alcohol
- -Isopropyl alcohol
- -Poly vinyl pyrrolidine
- -Poly ethylene glycol
- -Isopropyl myristate[39,40,41,42,43,44.]

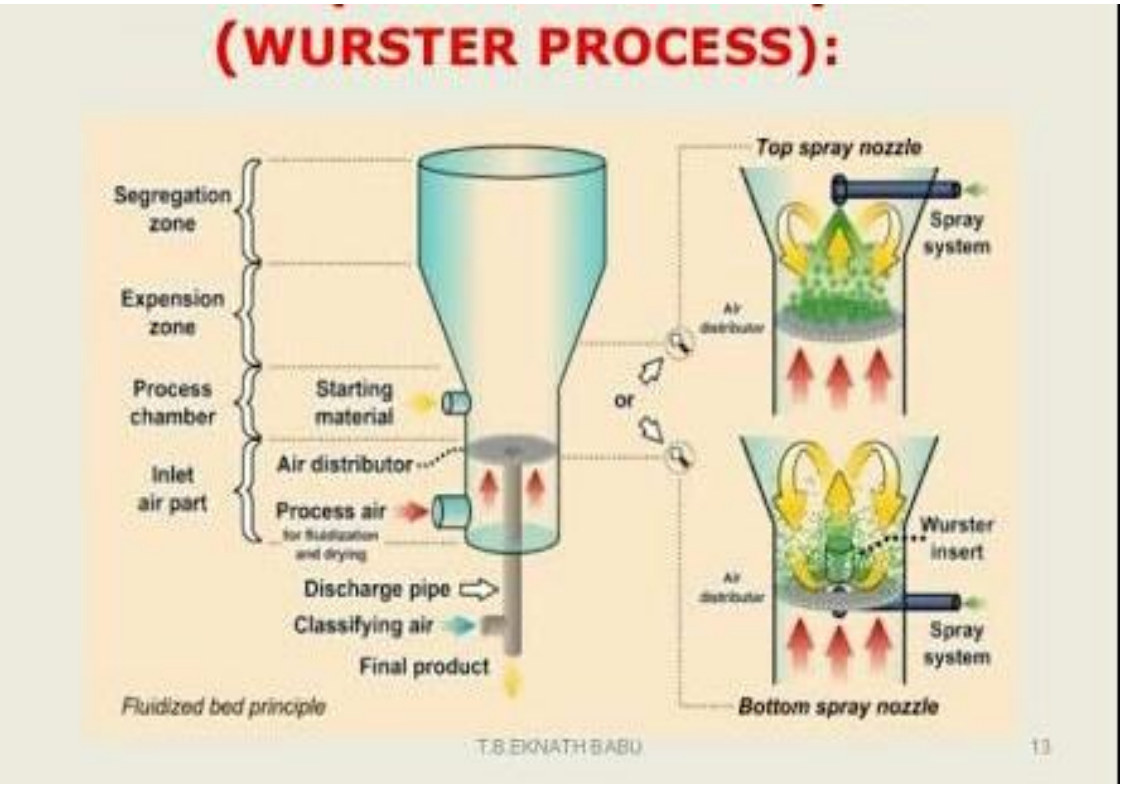
METHODS OF MICRO ENCAPSULATION: -

PHYSICAL METHODS
- Air suspension method
- Coacervation phase separation
- Spray drying
- Spray congealing
- Multi orifice centrifugal process
- Pan coating

CHEMICAL METHODS

Polymerization[45,46,47.]

AIR SUSPENSION TECHNIQUE:



Principle:

It was invented by "DALE E. WURESTER". Basically, it consists of dispersion of solid core material in suspending air stream and spray coating of the suspended particles.[49,50.]

Process:

1. Within the air suspension channel, the core material is suspended towards upward by vaporised air stream applied from the air distribution plate.
2. The coating material is Passed through nozzle which gets sprayed on the core material by uniform distribution'
3. The process is continued till desired thickness is obtained.[51,52.]

Process variables:

1. Density, surface area, melting point, solubility, friability, crystallinity and flowability of core material.
2. Coating material concentration.
4.
3. Rate of applying the coating material.
4. Volume of air required to support and fluidize.
5. Amount of coating material required.
6. Inlet and outlet operating temperatures.[53,54.]

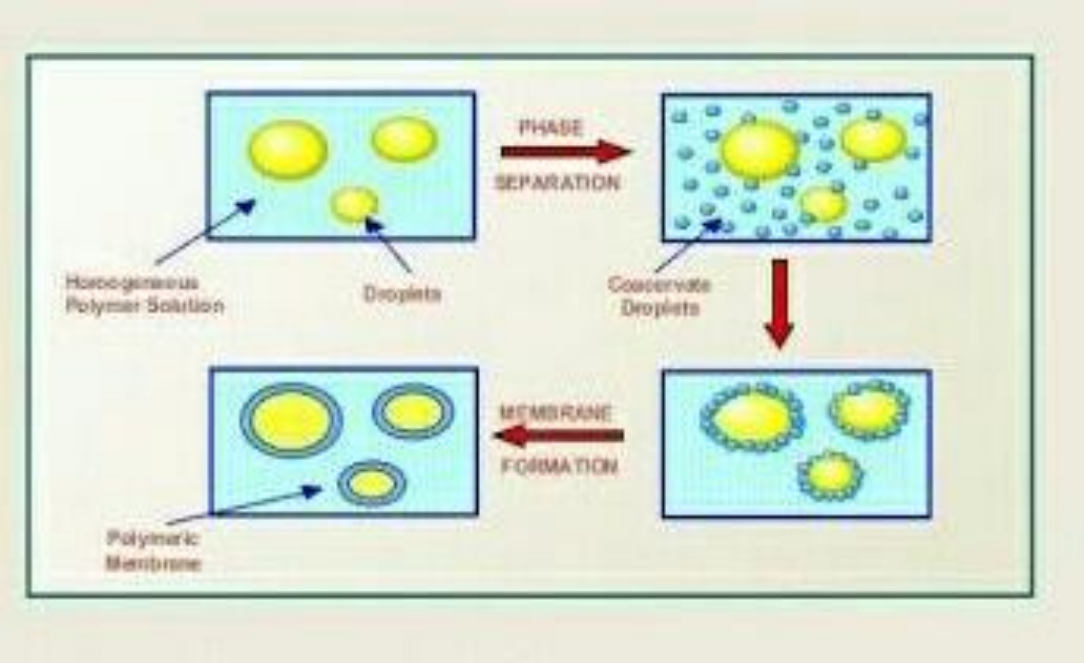
Advantages:

1. It is applicable to coat the materials in the form of solution, aqueous solution, emulsion or hot melts.
2. Applicable for both micro and macro encapsulation due to small particle size.
3. Core materials comprised of micron or sub-micron particles can be effectively encapsulated.
4. Improved control and flexibility compared to pan coating.[55,56.]

Disadvantages:

1. Applicable to only solids.
2. High skill is required.
3. Agglomeration of solid may takes place.[57,58.]

COACERVATION PHASE SEPERATION: -



Principle: Desolation of coating material mixture forms the coacervates. The chain of coacervates surrounds each individual particle to form microcapsules, these are collected and dried.

Process:

The process involves three steps

1. Formation of three immiscible phases
2. Deposition of coating material
3. Rigidization of micro capsules

Step 1: To form the three phases the core material is dispersed in a solution of coating polymer, the solvent for the polymer is liquid manufacturing vehicle phase.

In order to make the coating material phase immiscible with the solvent, these techniques are followed

Changing the temperature of polymeric solution: Due to the change in temperature, coating material separates from polymeric solution and forms coacervates.

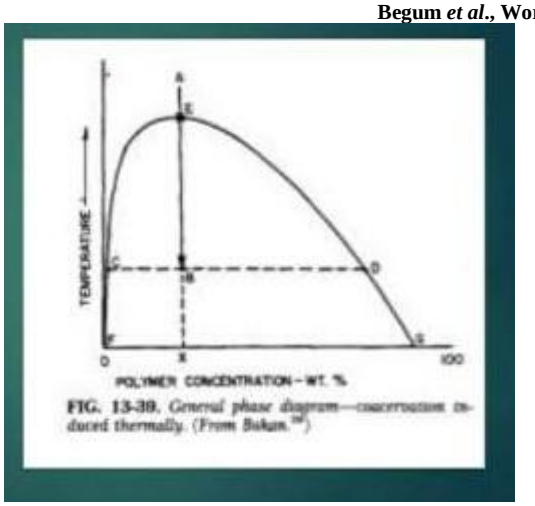
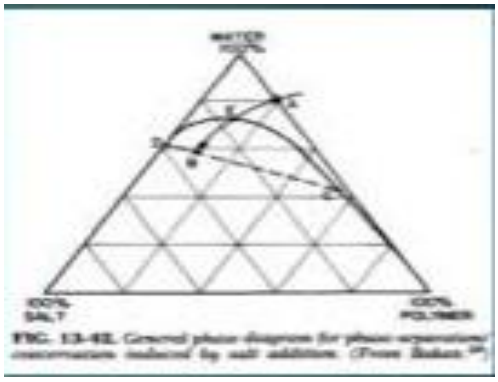
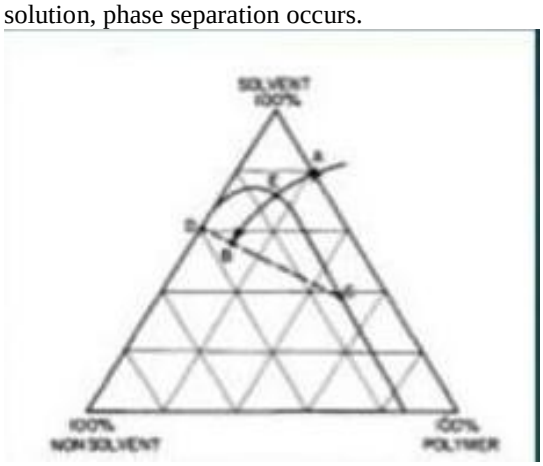


FIG. 13-39. *General phase diagram—coacervation induced thermally. (From Bakan.*[59])

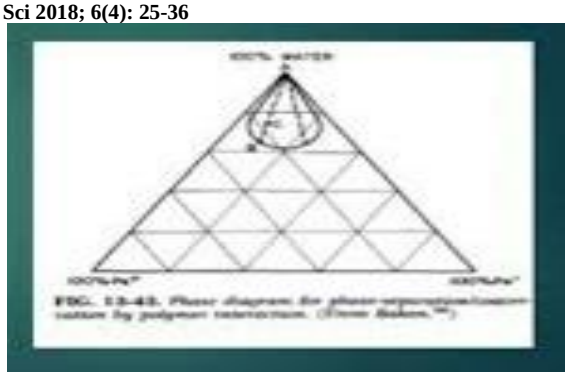
Addition of salt: By adding salt to the coating material mixture phase separation occurs due to the formation of coacervates.



Addition of non-solvent: Coacervation occurs due to addition of non-solvents to the polymeric solution, phase separation occurs.



Addition of incompatible polymer to the polymeric solution: Phase separation takes place due to the mixing of two immiscible substances.



Step 2

Deposition of the liquid polymer upon the core material. Application of coating material on the core material occurs if the polymer is adsorbed at the interface between core and coating material.

Step 3

Formation of self-sustaining micro capsule which involves rigidizing the coating by thermal or cross linking or desolvation techniques.[59,60,61,62.]

Advantages:

1. Versatile process
2. Uniform coating can be obtained
3. It is easy and fast process
4. Uniform size of the capsules can be obtained

Disadvantages:

1. Scale up is difficult
2. Agglomeration may occur.[63,64.]

MULTI-ORIFICE CENTRIFUGAL PROCESS

The Southwest Research Institute has developed a mechanical process for production of microcapsules by using centrifugal force.

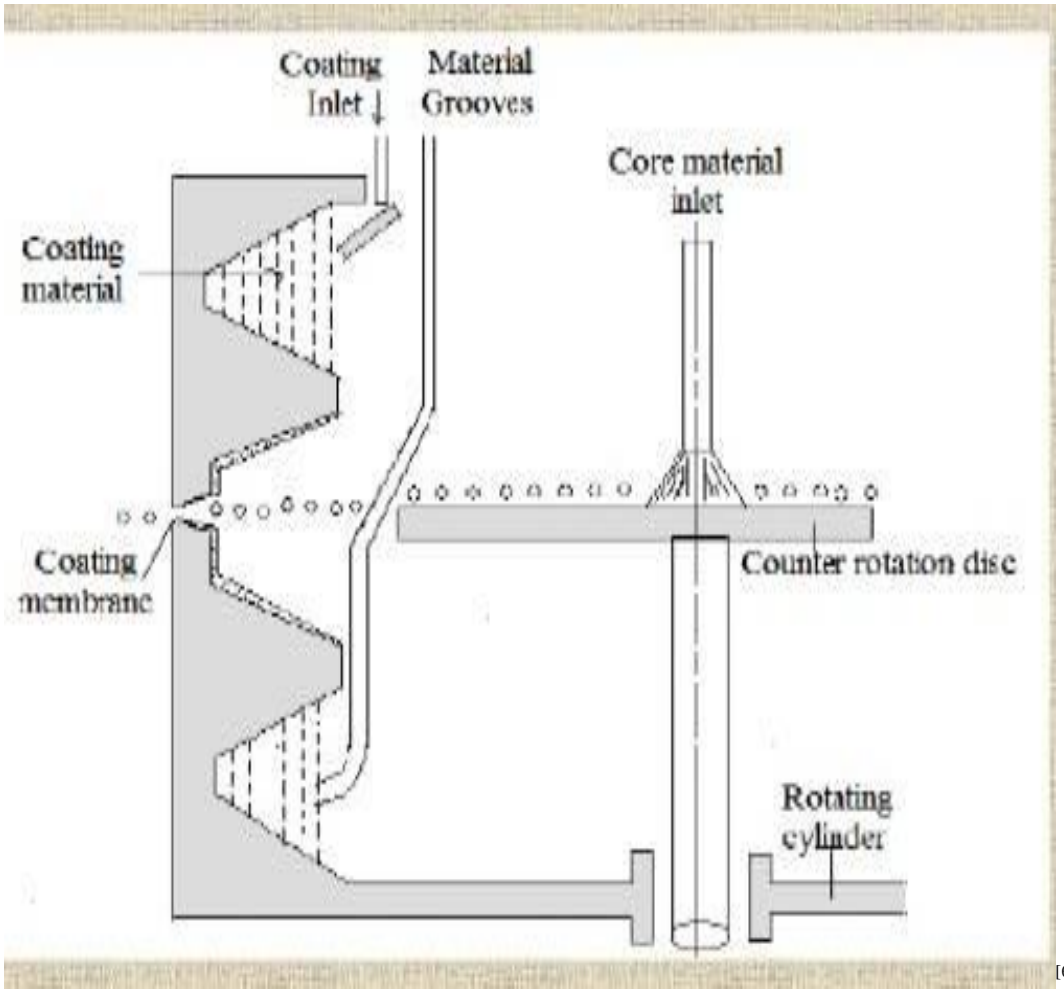
Principle:

The process utilizes the centrifugal force to hurl the core material into coating material to obtain microcapsules

Process:

1. The coating material enters through the coating material inlet which is passed through the 1 and 3 circumferential grooves.
2. The coating material is pumped such that it should overflow through the grooves and edges of the intermediate grooves.
3. The coating material enters into the counter-sunk portion and forms a film across the orifice.
4. The counter rotating disc mounted within the cylinder disperses the core material fed through the centrally located inner.
5. Counter rotating disc makes each core particle to hurl and move towards the orifice.
6. The core material reaches at the orifice and encounters the coating material membrane.

7. The impact and the centrifugal force makes the core material to encounter the coating material membrane results in formation of micro capsules.
8. The micro capsules are collected and dried[68,69.]



[65,66,67.]

Process variables:

- Rotation speed of rotating cylinder.
- Concentration of core and coating material.
- Surface tension of coating material.
- Viscosity of the core material and coating material.[70.]

Advantages:

1. Capable to encapsulate liquid and solid core material.
2. Core material can be supplied in the form of slurry and dried powder.
3. Diverse coating material can be used.

Disadvantages:

1. Wastage of coating material may take place.
2. High temperature is needed for drying of microcapsules.[71,72.]

SPRAY DRYING:

Principle:

In this microcapsule are formed by spraying core and coating material into the chamber which is at high temperature.

Process variables:

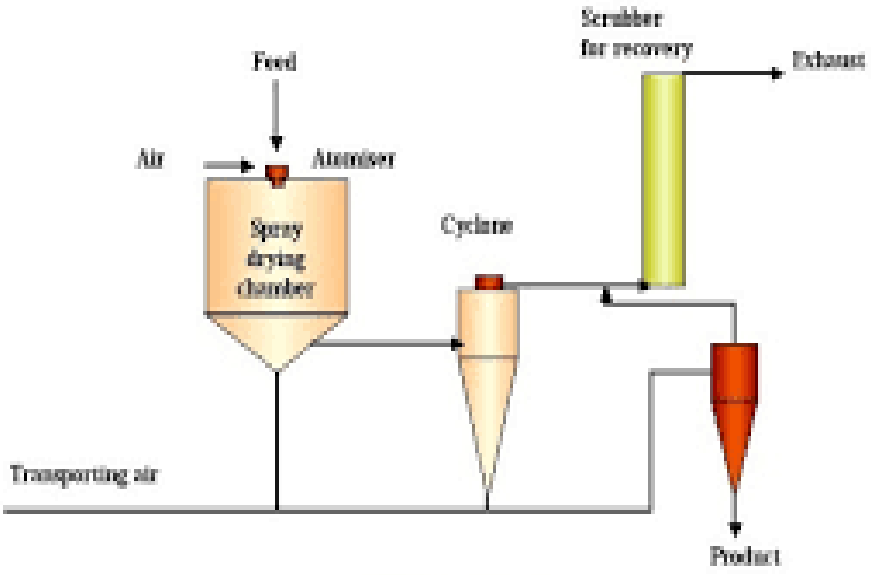
Viscosity, uniformity, concentration of core & core material, feed rate of atomization drying rate.[75,76.]

Advantages:

1. It is versatile process.
2. It provides good control of final properties such as particle size, flowability,bulk density and mechanical strength.
3. It is suitable for vitamins, hormones, plasma, serum, dextrin's, chloramphenicol can be encapsulated.

Disadvantages:

1. High cost, bulky and expensive.
2. Thermal instability due to loss of high temperature.[77,78.]



SPRAY CONGEALING:

Principle:

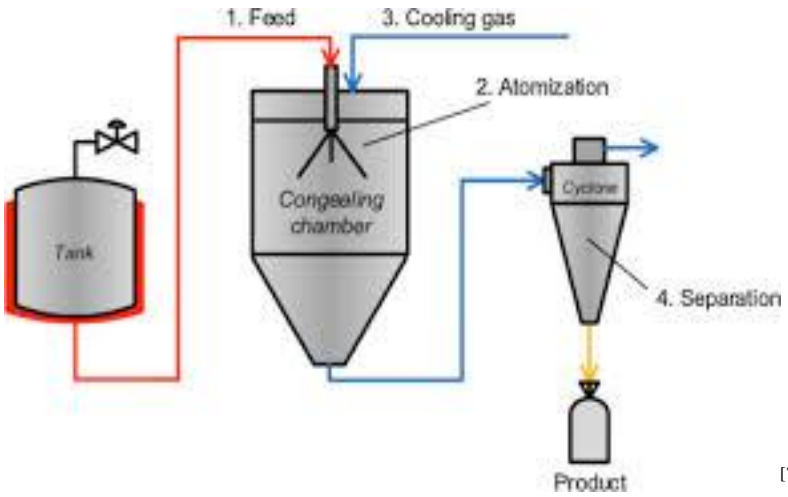
It is similar to spray drying but in this case the micro capsules are formed at lower temperature.

Advantages:

1. Uniform coating.
2. Waxes, sugars, polymers, amino acids can be encapsulated.

Disadvantages:

1. Expensive.
2. Scale up is difficult, rapid release of drug.[81,82.]



[79,80.]

POLYMERIZATION-COMPLEX EMULSION PROCESS

Principle:

It involves the reaction of monomeric units at the interface between core and coating material.The continuous phase is usually a liquid (or) gas and therefore polymerization occurs at liquid-liquid, liquid-gas, solid-liquid.[83,84.

Advantages:

Easy and uniform coating can be done.

Disadvantages:

Agglomeration due to separation.[85,86.]

PAN COATING:

Principle: In this process microcapsules are obtained by pouring a coating solution on to a moving core material in a standard coating pan.

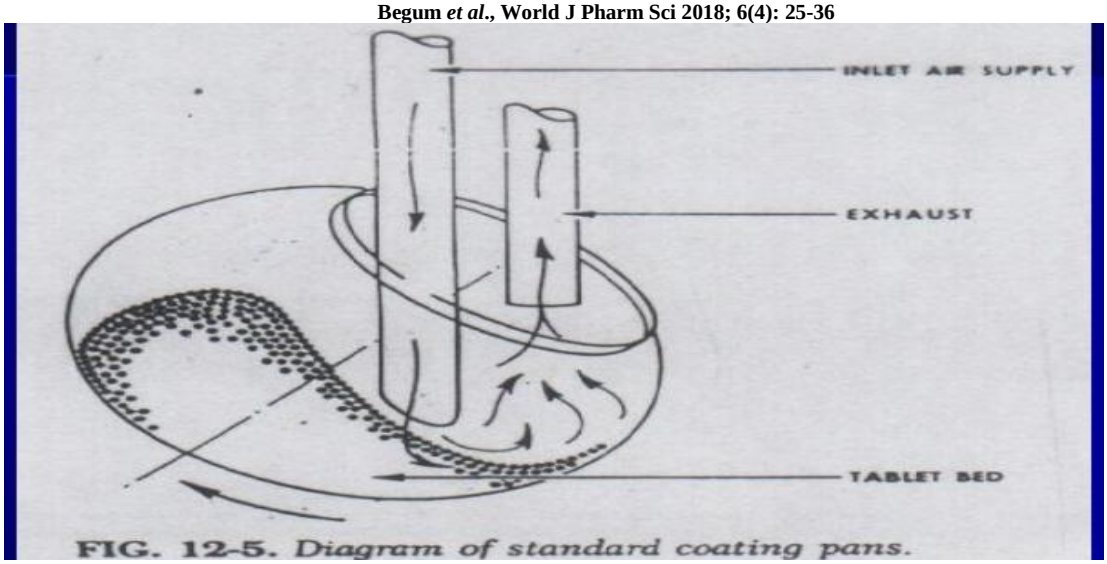


FIG. 12-5. *Diagram of standard coating pans.*

Process: The core material is sieved to remove the dust particles and then added to the coating pan. The coating material is then added through coating solution inlet and moreover with the aid of spray nozzle it gets sprayed on the core material till the desired thickness is obtained. Excess solvent is removed by passing warm air.[87,88.]

Advantages:

1. Easy and low cost.
2. Controlled release beads can be prepared.

Disadvantages:

Skilled person is needed.[89,90.]

EVALUATION OF MICRO CAPSULES:

Percentage yield: The total amount of micro capsules obtained was weighed and the percentage yield calculated taking into consideration the weight of the drug and polymer.

Percentage yield=Amount of micro capsule obtained/Theoretical Amount*100

Scanning electron microscopy: Scanning electron photomicrographs of drug loaded ethyl cellulose microcapsules were taken.A small amount of microcapsules was spread on gold slub and was placed in the scanning electron microscopy chamber. The SEM photomicrographs was taken at the acceleration voltage of 20 KV.

Particle size analysis: For size distribution analysis, different sizes in a batch were separated by sieving by using a set of standard sieves. The amounts retained on different sieves were weighed.

Encapsulation efficiency: Encapsulation efficiency was calculated using the formula:

Encapsulation efficiency=Actual Drug Content/Theoretical Drug Content*100.[91,92,93.]

CONCLUSION

Micro encapsulation refers to a phenomenon in which drug compounds are safely encapsulated as a small capsule in order to achieve most stable product. This technology brings huge impact in the area of pharmaceutical research which also offers special appearance in controlled and target drug delivery system. These capsules protect the active ingredient from surrounding environment.[94,95.]

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