A REVIEW ON MICROENCAPSULATION & TRANSDERMAL PATCHES

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Abstract- **Microencapsulation is a versatile technology that involves the encapsulation of small particles or droplets within a protective coating, typically on a micron or submicron scale. This process finds widespread application in various industries, ranging from pharmaceuticals and food to cosmetics and materials science. In the pharmaceutical sector, microencapsulation plays a pivotal role in enhancing drug delivery systems. It offers controlled release, improved stability, and protection for sensitive active ingredients. The use of polymers or lipids as coating materials ensures isolation from external factors, allowing for precise control over the release kinetics of the encapsulated substances. Transdermal patches have emerged as a sophisticated and patient-friendly drug delivery system. These patches deliver medications through the skin, providing a non-invasive alternative to traditional oral or injectable routes. The patches adhere to the skin, allowing for controlled and sustained release of drugs over an extended period. These abstract reviews the innovations and applications of transdermal patches, discussing the various formulations, materials, and manufacturing techniques employed in their development. The patches offer advantages such as improved patient compliance, reduced side effects, and a steady release of medications, making them valuable in diverse therapeutic areas. This overview underscores the evolving landscape of microencapsulation & transdermal patch technology and its potential impact on the future of drug delivery systems.**

Keywords- **Microencapsulation, Transdermal patches, Pharmaceuticals.**

INTRODUCTION

The formulation development is important component of pharmaceutical development and therapeutic effect or commercial realization of product by delivering quality safety and capacity. The main parts of formulation development are product development methods like drug discovery, research etc. Drug pre-formulation studies are the first step in formulation development. This phase, we identify the physical, chemical, and mechanical properties of drug to determine the excipient, or inactive ingredient.

Microencapsulation is a process in which small particles or drops are surrounded by a lid to give a small capsule with many useful properties. Microencapsulation can be used to surround solids, liquid, or gases micrometer wall of hard or soft dissolved film, in reduce dose rate and avoid degradation of drugs. Relatively simple in the form of a microcapsule is a small uniform sphere a wall around it. The material inside the microcapsule is called core, inner phase or filling, while the wall is sometimes called a shell cover or film. Some material such as alginate, which can be used as a mixture to capture material in interest most microcapsules have pores a new micrometer in diameter millimeter. The microencapsulation technique depends physical and chemical properties of the material be encapsulated. The core can be crystalline, toothed adsorbent particle, emulsion, puckering emulsion, a solid suspension.

Microencapsulation gets a lot of attention basically, developmentally, and commercially. This interest is the purpose of this chapter to better highlight the description

The microencapsulation method discussed is air suspension storage-phase separation, spray drying and solidification and polymerization techniques. Research from the ever-expending patent and published literature show that not all microencapsulation techniques are still belonging to the methods mentioned in this chapter, method describe. Mostly highly developed and widely used commercial processes, although some may not be applicable to pharmaceutical at this time.

In defense application this technology is used for fabrication of self-heating composites which form an integral part of aerospace structure. Microencapsulation also used to design special fabric for military personnel thanks to their enhanced chemical protection against chemicals microencapsulation has become increasingly popular in the pharmaceutical industry as well as for many other everyday products and process use.

Depending on the physical and chemical properties of the core, the composition of the shell materials and the microencapsulation method used, different capsules are obtained a simple sphere surrounded by wall material, capsule

with an irregular core, several separate cores with a wall. Material, multi- wall microcapsule and a continuous coating of core particles embedded in the matrix of the wall material.

MICROENCAPSULATION

Microencapsulation is a process in which tiny particles or droplets of one substance are enveloped or encapsulated within a coating material, typically in the micron or submicron size range. This encapsulation technique is employed across various industries, including pharmaceuticals, food, cosmetics, and materials science.

In microencapsulation, the core material, which can be a solid, liquid, or gas, is surrounded by a protective or functional coating. This coating, often made of polymers or lipids, isolates and shields the core material from external factors such as light, moisture, or chemical reactions. The resulting microcapsules can exhibit controlled release properties, improved stability, and enhanced delivery of active ingredients.

Microencapsulation finds diverse applications, such as in the pharmaceutical industry for controlled drug release, in the food industry for flavor masking or controlled release of additives, and in cosmetics for controlled release of fragrances. The versatility of microencapsulation makes it a valuable technology for tailoring and optimizing the performance of various products and formulations.

ADVANTAGE OF MICROENCAPSULATION

* Protection of volatile substance against premature evaporation and extension of shelf life.
* Protection of active ingredients against oxidation and during food process.
* Control of the release of active substance in the gastrointestinal tract of targeted animals.
* To alter the drug release and separation of reactive core from other materials.
* To reduce the reactivity of the core in relation to the outside environment.
* To convert liquid to solid from and mask the core taste.
* Protect the GIT from irritant effects of the drug.
* Protection of liquid crystals.
* To increase bioavailability.

DISADVANTAGE OF MICRO ENCAPSULATION

*Microencapsulation techniques are high cost
* Difficult to obtain continuous and uniform film.
* More skill and knowledge is required
* Difficult to achieve continuous and uniform film.
* Shelf life of hygroscopic drugs is reduced.

CLASSIFICATION OF MICROENCAPSULATION

Following classification of microencapsulation

A) Mononuclear – Mononuclear (core-shell) microcapsules contain a shell around a core.
B) Polynuclear- Although polynuclear capsules have many cores enclosed within the shell.
C) Matrix- Core materials in matrix encapsulation, the material is evenly distributed in the shell of material.

MATERIALS FOR MICROENCAPSULATION

The microencapsulation contains two types of material such as, Core material and Coating material.

Core-Material

A core material refers to the central or innermost component of a composite structure, typically surrounded or enveloped by another material. In various industries, the selection of the core material is crucial for determining the structural, functional, or performance characteristics of the final product.

For example, in pharmaceuticals, the core material of a tablet or capsule is the active pharmaceutical ingredient (API) – the substance responsible for the therapeutic effect. The choice of the core material in drug formulations influences factors such as bioavailability, stability, and release profile.

In the context of composite materials, the core material often serves as a lightweight, yet sturdy, central component sandwiched between outer layers. For instance, in aerospace applications, sandwich panels may have a lightweight core material like foam or honeycomb structures, providing strength and stiffness while minimizing overall weight.

Ultimately, the properties and suitability of the core material are tailored to meet the specific requirements of the intended application, emphasizing its critical role in determining the overall performance and functionality of diverse products.

COATING MATERIAL

Coating materials play a pivotal role in various industries, offering protective, functional, or aesthetic enhancements to diverse surfaces and products.

In manufacturing and construction, protective coatings often use materials like epoxy, polyurethane, or powder coatings to shield surfaces from corrosion, wear, or environmental damage. These coatings contribute to the durability and longevity of structures and equipment.

In pharmaceuticals, coating materials are crucial in the formulation of tablets and capsules. Common coating materials include cellulose derivatives, polymethacrylates, and waxes. These coatings serve multiple purposes, such as masking taste, providing enteric protection, or controlling the release of active pharmaceutical ingredients.

In the realm of consumer goods, coatings are frequently applied to enhance aesthetics, improve resistance to scratches or stains, and ensure product longevity. Materials like paints, varnishes, and specialized coatings are used for this purpose.

The choice of coating material depends on the specific application and desired properties, highlighting the significance of these materials in achieving functional and performance objectives across diverse industries.

MICROENCAPSULATION TECHNIQUE

Physical methods:

* Air suspension techniques (Wurster)
* Coacervation Process
* Spray Drying and Congealing
* Pan Coating
* Solvent Evaporation
* Polymerization
* Extrusion
* Single and Double Emulsion Technique
* Supercritical fluid Anti Solvent method (SAS)
* Nozzle Vibration Technique

Chemical methods:

* Interfacial polymerization
* In-situ polymerization
* Matrix polymerization

*PHYSICAL METHODS:

1)AIR SUSPENSION TECHNIQUE (WURSTER)

The air suspension technique is a widely employed method in pharmaceutical manufacturing to produce coated particles, especially in the context of tablets and capsules.

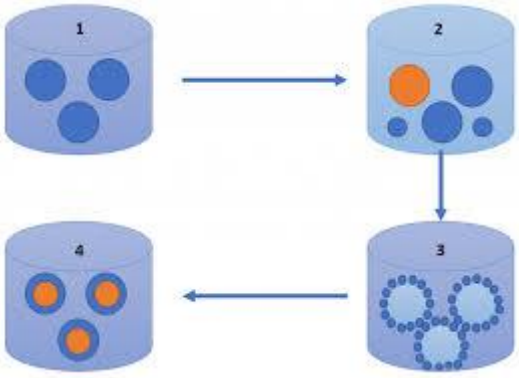
In the air suspension process, solid particles, typically pharmaceutical granules or cores, are suspended in an air stream within a coating apparatus. A liquid coating material, often a polymer solution or dispersion, is then sprayed onto the suspended particles. The simultaneous action of the air flow and the spraying process ensures uniform coating of the particles.

This technique is known for its versatility, providing control over the coating thickness and the ability to encapsulate active ingredients, control release rates, or mask taste. Air suspension coating is commonly used in the pharmaceutical industry to improve the stability, appearance, and performance of oral dosage forms. The efficiency and reproducibility of this method contribute to its widespread adoption in pharmaceutical formulation processes.

2)COACERVATION PROCESS

Coacervation is a process utilized in the pharmaceutical, food, and cosmetic industries for the encapsulation of active ingredients, flavors, or fragrances. It involves the phase separation of a polymer solution into two immiscible liquid phases: a polymer-rich coacervate phase and a polymer-poor solvent phase.

During coacervation, a polymer is dissolved in a solvent, and then a phase separation is induced by various methods such as temperature changes or the addition of a coacervating agent. This results in the formation of droplets (the coacervate) surrounded by the polymer-poor phase. The coacervate phase can encapsulate bioactive substances or flavoring agents, offering protection and controlled release. The versatility of coacervation lies in its ability to produce microcapsules or microspheres with tailored properties, such as size, thickness, and composition. This process is valued for its simplicity, scalability, and applicability to a wide range of substances. Coacervation finds diverse applications, including controlled drug delivery, flavor encapsulation, and the creation of functional coatings in various industries.



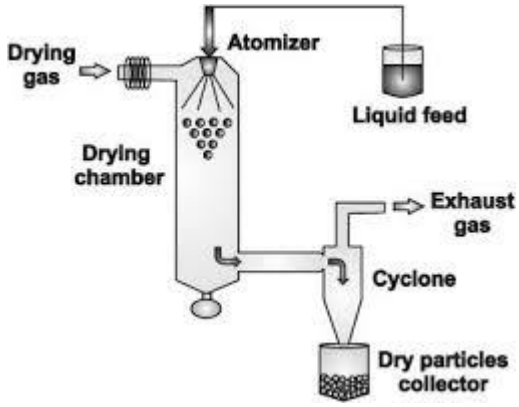
3)SPRAY DRYING AND CONGEALING

Spray drying and congealing are distinct techniques employed in the pharmaceutical and food industries to produce powders and encapsulated materials.

Spray Drying: Spray drying involves the atomization of a liquid feed, typically a solution or a suspension, into fine droplets. These droplets are then exposed to a stream of hot air, causing rapid evaporation of the solvent and leaving behind dried particles. This method is widely used for producing powders with controlled particle sizes and improved solubility. Applications range from pharmaceuticals to food products, allowing the creation of easily dispersible and shelf-stable powders.

Congealing: Congealing is a process in which a melted or dissolved substance is cooled and solidified to form particles. In the context of encapsulation, congealing often refers to the cooling of a molten substance around a core material, resulting in the formation of a solid shell. This technique is commonly used in the production of encapsulated flavors, pharmaceuticals, and nutritional supplements, providing a protective coating for sensitive ingredients.

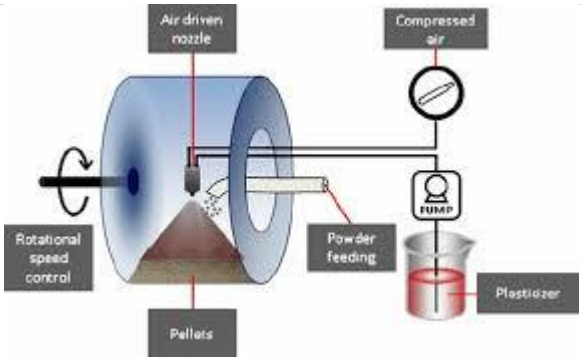
Both spray drying and congealing offer advantages in terms of process efficiency, versatility, and the ability to control product characteristics. The selection between these methods depends on the specific requirements of the desired end product.



4)PAN COATITNG

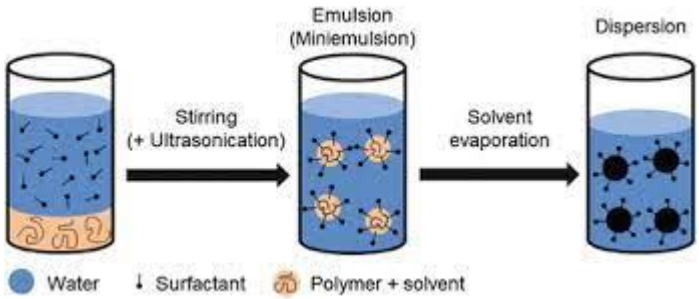
Pan coating is a widely used technique in the pharmaceutical and confectionery industries for the application of a thin and uniform coating onto solid particles, such as tablets or candies.

In pan coating, the product to be coated is placed in a rotating pan or drum. A coating solution, typically containing polymers, colorants, or other additives dissolved in a solvent, is sprayed onto the rotating particles. As the pan continues to rotate, the solvent evaporates, leaving a thin and even coating on the surface of the particles.
This method offers advantages such as precise control over coating thickness, improved product appearance, and enhanced stability. Pan coating is favored for its simplicity, cost-effectiveness, and suitability for small to large-scale production. However, careful consideration of the formulation and process parameters is necessary to achieve optimal coating quality and uniformity.



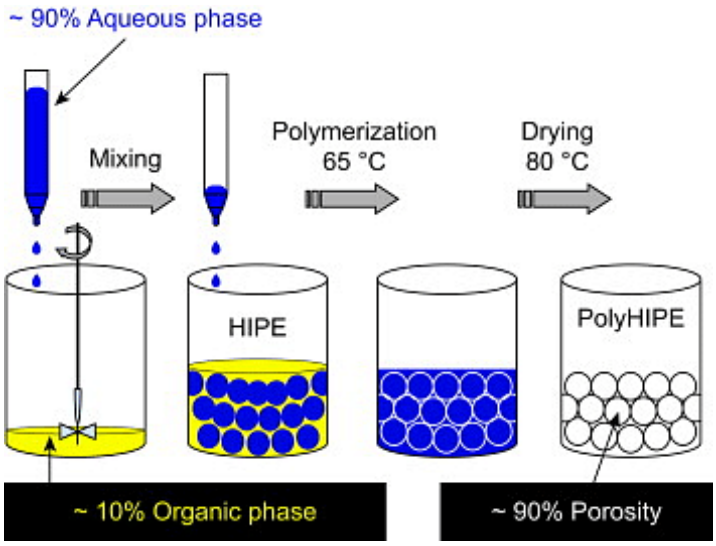
5)SOLVENT EVAPORATION

Solvent evaporation is a common technique used in various industries, especially in pharmaceuticals and materials science, for the controlled deposition of thin films or the fabrication of micro and nanoparticles.
In solvent evaporation, a solution containing a solute (such as a polymer or a drug) dissolved in a volatile solvent is applied onto a substrate. The solvent is then allowed to evaporate, leaving behind a solid film or particles. This method is employed to achieve precise control over the morphology, size, and distribution of the deposited material.
The key advantage of solvent evaporation lies in its simplicity and versatility. It is particularly useful for creating drug delivery systems, coatings, and encapsulated materials. Careful selection of solvents and process parameters allows for customization of the final product's characteristics. However, challenges such as solvent toxicity and the need for optimization to prevent undesired effects make solvent evaporation a subject of ongoing research for safer and more efficient applications.



6)POLYMERIZATION

Polymerization is a fundamental chemical process in which small, reactive molecules, called monomers, chemically bond together to form larger and more complex structures known as polymers. This reaction typically involves the breaking of double or triple bonds between carbon atoms in the monomers, allowing them to link and create a repeating chain.
There are various methods of polymerization, including addition (chain-growth) polymerization and condensation (step-growth) polymerization. In addition polymerization, monomers add to a growing polymer chain successively, resulting in a linear or branched structure. In condensation polymerization, monomers react to form polymers while eliminating small molecules such as water or alcohol.
Polymerization is a crucial process in the production of a wide range of materials, from synthetic plastics and rubber to biological macromolecules like proteins and DNA. The properties of the resulting polymer, such as its strength, flexibility, and thermal characteristics, can be tailored by adjusting the choice of monomers and the conditions of the polymerization reaction. This versatility makes polymerization a cornerstone of both industrial manufacturing and scientific research.

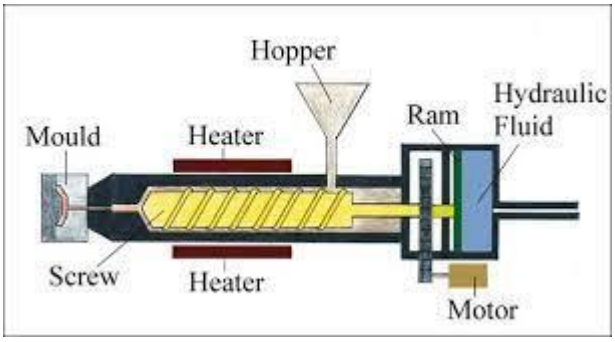


7)EXTRUSION

Extrusion is a versatile manufacturing process widely utilized across industries for shaping and forming materials, especially polymers and metals, into various products with a consistent cross-sectional profile.

In extrusion, a material, typically in a molten or plasticized state, is forced through a shaped die to produce a continuous profile or length. This method is commonly associated with plastics manufacturing, where polymer pellets are melted and forced through a die to create products like pipes, tubes, and sheets.

The process offers several advantages, including high production rates, precision in creating complex shapes, and the ability to work with a wide range of materials. Extrusion is extensively employed in construction, automotive, packaging, and other industries due to its efficiency and versatility in producing components with uniform cross-sections and tailored properties.



8) SINGLE AND DOUBLE EMULSION TECHNIQUES

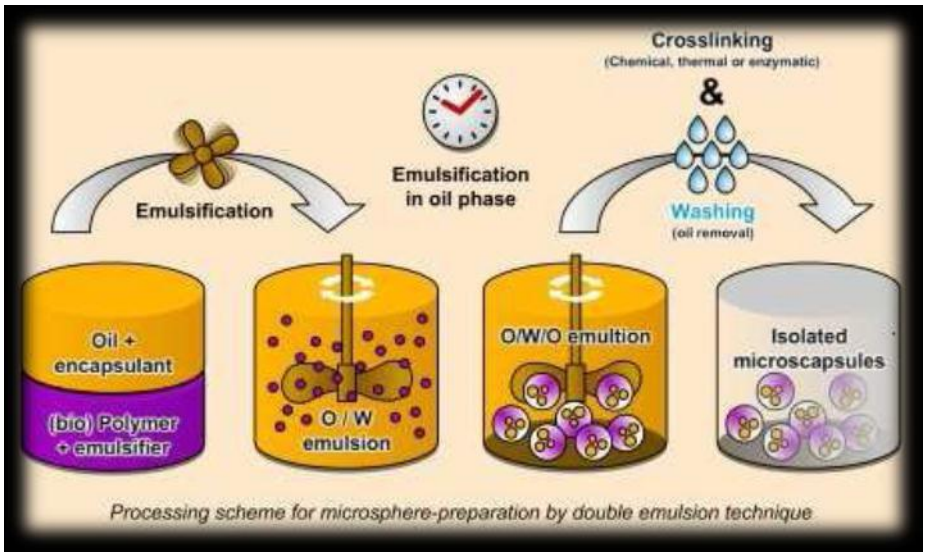
Single emulsion techniques, in these techniques an aqueous polymer solution is dispersed in to the organic phase in oil/chloroform with continuous stirring. This process is called sonication.

Single and double emulsion techniques are widely employed in the field of pharmaceuticals, cosmetics, and materials science for the encapsulation of substances and the creation of complex microstructures.

Single Emulsion Technique: In the single emulsion technique, a liquid (usually an oil phase) is emulsified into another liquid (typically an aqueous phase) with the help of an emulsifying agent. This results in the formation of droplets of one liquid dispersed in the other. This technique is commonly used for encapsulating hydrophobic substances within droplets, providing a protective environment for sensitive compounds. It is a straightforward method but may face challenges such as low encapsulation efficiency.

Double Emulsion Technique: The double emulsion technique, also known as the water-in-oil-in-water (W/O/W) or oil-in-water-in-oil (O/W/O) technique, involves an additional emulsification step. A primary emulsion is first formed (either water-in-oil or oil-in-water), and then this emulsion is emulsified into another liquid phase. This results in the creation of droplets within droplets. Double emulsion techniques are often used for controlled drug delivery systems, where the inner droplets may contain the active substance, and the outer droplets act as a protective layer. This method allows for better control over the release of encapsulated materials.

Both single and double emulsion techniques play a crucial role in tailoring the characteristics of micro- and nanostructures, offering versatility in designing delivery systems for various applications.

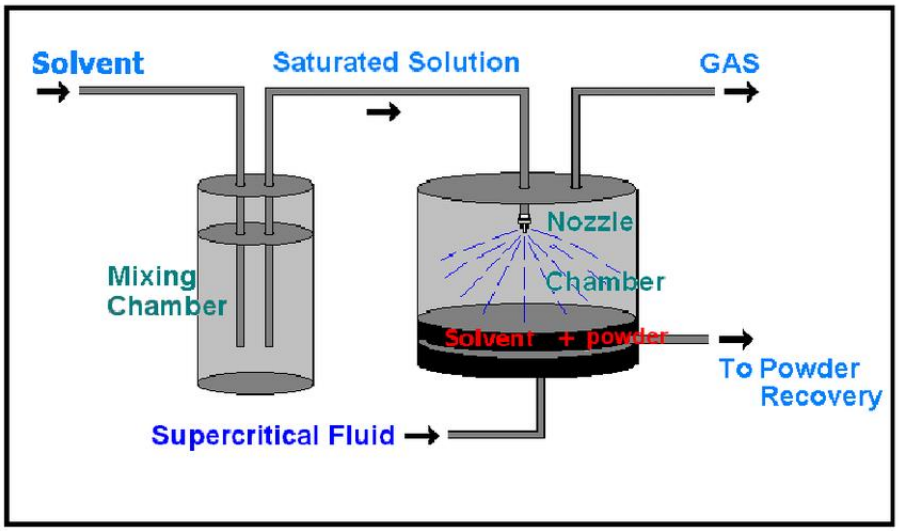


9)**SUPERCRITICAL FLUID ANTI SOLVENT METHOD (SAS)**

The supercritical fluid anti-solvent (SAS) method is a cutting-edge technique in the field of particle engineering and pharmaceutical formulation. This method involves the use of a supercritical fluid, commonly carbon dioxide, as an anti-solvent to precipitate solutes from a liquid solution.

In the SAS process, a supercritical fluid is brought into contact with a solution containing the solute of interest. As the supercritical fluid rapidly diffuses into the liquid solution, a controlled reduction in solubility occurs, leading to the precipitation of finely divided particles. The unique properties of supercritical fluids, such as their tunable density and low viscosity, make them effective in achieving precise control over particle size and morphology.

The SAS method is particularly valuable in pharmaceuticals, where it is employed to produce drug particles with enhanced bioavailability and controlled release characteristics. Its versatility extends to applications in materials science and nanotechnology, where the ability to tailor particle properties at a microscopic level is crucial for achieving desired material performance. The SAS method stands as an innovative and efficient approach in the realm of advanced materials synthesis.

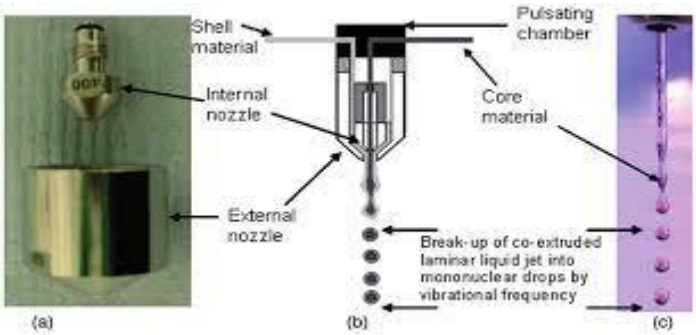


10)NOZZLE VIBRATION TECHNIQUES

Nozzle vibration polymerization involves the application of mechanical vibrations to a polymerization nozzle during the polymerization process. This technique is utilized to enhance the dispersion of reactants and improve the quality of the resulting polymer.

By subjecting the polymerization nozzle to controlled vibrations, the polymerization reaction benefits from increased agitation and mixing at the molecular level. This leads to better control over polymer morphology, particle size, and distribution. The fine-tuning of these parameters is crucial in various industrial applications, such as the production of specialty polymers, coatings, and advanced materials.

Nozzle vibration polymerization offers advantages such as improved reaction kinetics and the ability to produce polymers with tailored properties. This method finds applications in industries where precise control over polymer characteristics is essential for achieving desired product performance.



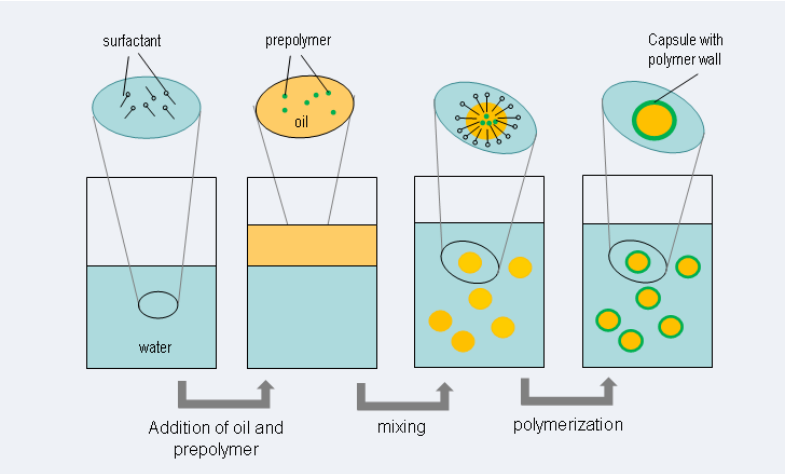
* **CHEMICAL METHODS:**

1) INTERFACIAL POLYMERIZATION

Interfacial polymerization is a synthetic technique where polymerization occurs at the interface between two immiscible phases, typically a liquid and a solid. This method is widely used for producing thin films, membranes, and coatings with specific properties.

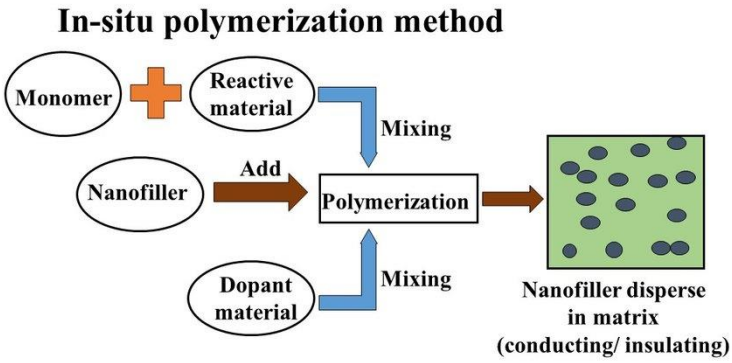
In interfacial polymerization, two reactive monomers are dissolved in separate phases, and they come into contact at the interface. The reaction between these monomers leads to the formation of a polymer film at the interfacial boundary. This technique is particularly advantageous for creating polymers with high molecular weights and unique structures.

Common applications of interfacial polymerization include the production of thin-film composite membranes for water purification and gas separation, as well as the synthesis of polyamide films used in various industrial processes. The method's ability to create well-defined structures and control film thickness makes it a valuable tool in materials science and chemical engineering.



2) IN-SITU POLYMERIZATION

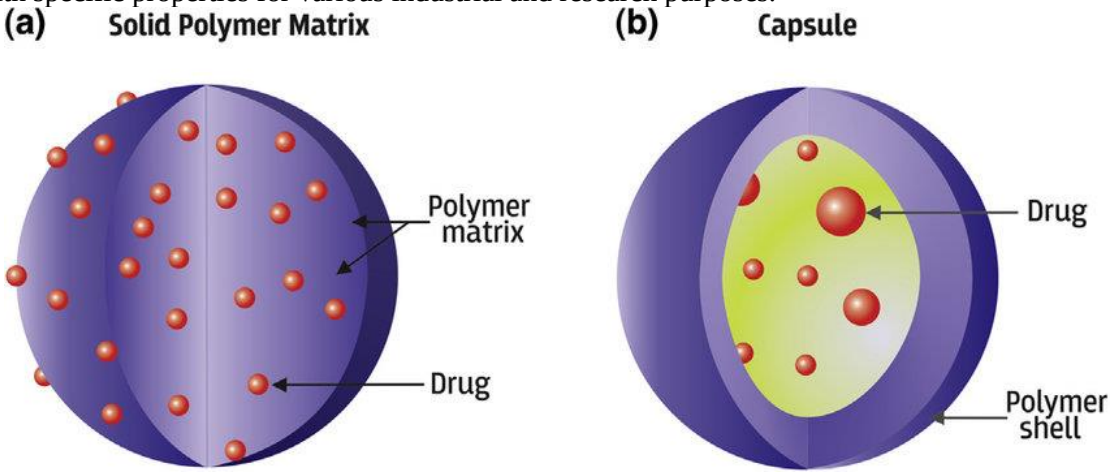
In situ polymerization is a polymerization technique where the formation of polymers occurs directly within the reaction medium, as opposed to the traditional method of polymerizing monomers separately and then blending the resulting polymers. This method offers several advantages, including increased control over polymer properties and reduced production costs. During in situ polymerization, monomers are introduced into a reaction system along with a catalyst or initiator. The polymerization reaction takes place within the system, leading to the formation of a polymer directly in the desired location. This technique is widely employed in various industries, such as the production of coatings, adhesives, and composite materials. The process is known for its versatility, allowing for the customization of polymer characteristics such as molecular weight, structure, and functionality. It also enables the incorporation of additives and reinforcement materials during the polymerization process, leading to enhanced material properties.



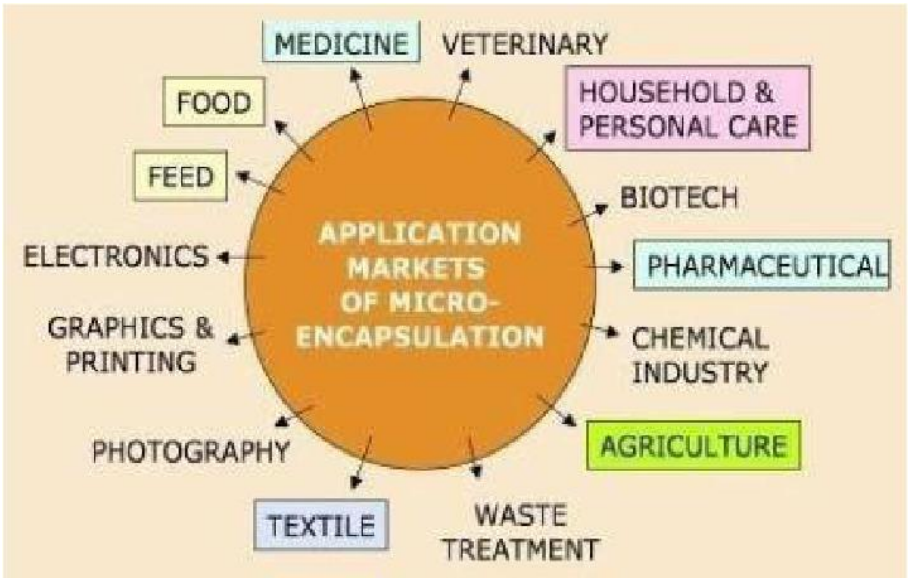
3)MATRIX POLYMERIZATION

Matrix polymerization refers to a process where a polymer is formed within a matrix or a surrounding medium. In this technique, the polymerization reaction occurs in the presence of a matrix material, which can be a solid, liquid, or gas. The matrix provides a confined environment for the polymerization, influencing the final properties and distribution of the polymer within the matrix.

This method is commonly used in composite material production, where a polymer matrix is reinforced with fibers or particles to enhance mechanical properties. Matrix polymerization allows for better control over the dispersion and orientation of the polymer within the matrix, leading to improved material performance in applications such as structural components, coatings, and advanced composites. The versatility of matrix polymerization makes it valuable for tailoring materials with specific properties for various industrial and research purposes.



*** APPLICATION OF MICROENCAPSULATION TECHNIQUES**



*** MEDICINE**

It is used when polymers are used to encapsulate active substances. This technique has been used to encapsulate a variety of fundamental materials, including insecticides, vitamins, tastes, and dyes.

*** VETERINARY**

It enhances the bioavailability absorption, and palatability of medication with good compliance. The use of microencapsulation in various drug delivery system for human health has been extensively researched. The veterinary pharmaceutical sciences are using microcapsules more and more frequently.

*** BIOTECH**

This technique is used to administer drug to specific areas. Microparticles are also used for controlled and sustained release. Macromolecules are encapsulated in microparticles to treat many diseases such as eye diseases, cancer, heart diseases and inflammation.

* **PHARMACEUTICS**

Drug release into the body can be slowed down with the use of microencapsulation. This may allow a single controlled release dosage to replace multiple non-encapsulated drug doses. Additionally, by avoiding high initial blood concentration of some drugs, it may decrease their toxic side effects.

***CHEMICAL INDUSTRY**

Chemicals can be released gradually and under control using a process called microencapsulation. During this procedure, tiny droplets or particles are contained within a coating to create tiny capsules, also known as microcapsules. The outer coating functions as a barrier wall, while the materials inside the capsules from the core.

***AGRICULTURE**

Microencapsulation using chitosan as an **encapsulant** is an emerging technology that protects active ingredients from degradation, reduces incompatibility problems and regulates active **ingredients,** providing solutions to various **problems** in the **agricultural** sector.

*** FEED**

An interesting aspect of the use of microcapsules in **food,** and especially **in** the material and **technology of their manufacture,** is that in some cases microcapsules retain **the** compound or bioactive extract **contained** in the product and **regulate** its release during **storage,** but in **others.**

***FOOD**

Microcapsules **protect** and **increase** the bioavailability and stability of **the** bioactive substance and natural **dyes,** but also improve **the taste,** masking the taste of food supplemented with vitamins and minerals and preventing their interaction with other ingredients, **facilitating** their delivery.

TRANSDERMAL PATCHES

INTRODUCTION-

Transdermal patches represent a revolutionary advancement in drug delivery systems, offering a non-invasive and patient-friendly approach to administering medications. This innovative technology has gained prominence across various medical fields due to its unique ability to deliver therapeutic compounds through the skin, bypassing traditional oral or injectable routes. The transdermal patch adheres to the skin's surface, providing controlled and sustained release of drugs over an extended period.

The appeal of transdermal patches lies in their capacity to enhance patient compliance, reduce side effects, and ensure a steady and consistent delivery of medications. This introduction sets the stage for an in-depth exploration of transdermal patches, delving into the various formulations, materials, and manufacturing techniques that contribute to their efficacy. As the field of drug delivery evolves, transdermal patches continue to play a pivotal role in optimizing therapeutic outcomes and reshaping the landscape of pharmaceutical technologies. This overview underscores the significance of transdermal patches in modern healthcare and highlights the potential for continued advancements in this dynamic and impactful drug delivery system.

ADVANTAGE

* It increases patient compliance, avoids primary metabolism
* It is non-invasive and avoids the **disadvantages** of parenteral therapy.
* Easy to use.
* Self-medication is possible
* Drug treatment can be stopped quickly by removing the application from the surface of the skin.

DISADVANTAGE

* **In some patients, it** may cause dermatitis at the application **site.**
* Don't offer a long-term commitment
* Only patented medicines can be made into chips.
*In some **cases,** it **was** placed behind the ear, **which makes** it uncomfortable for the patient

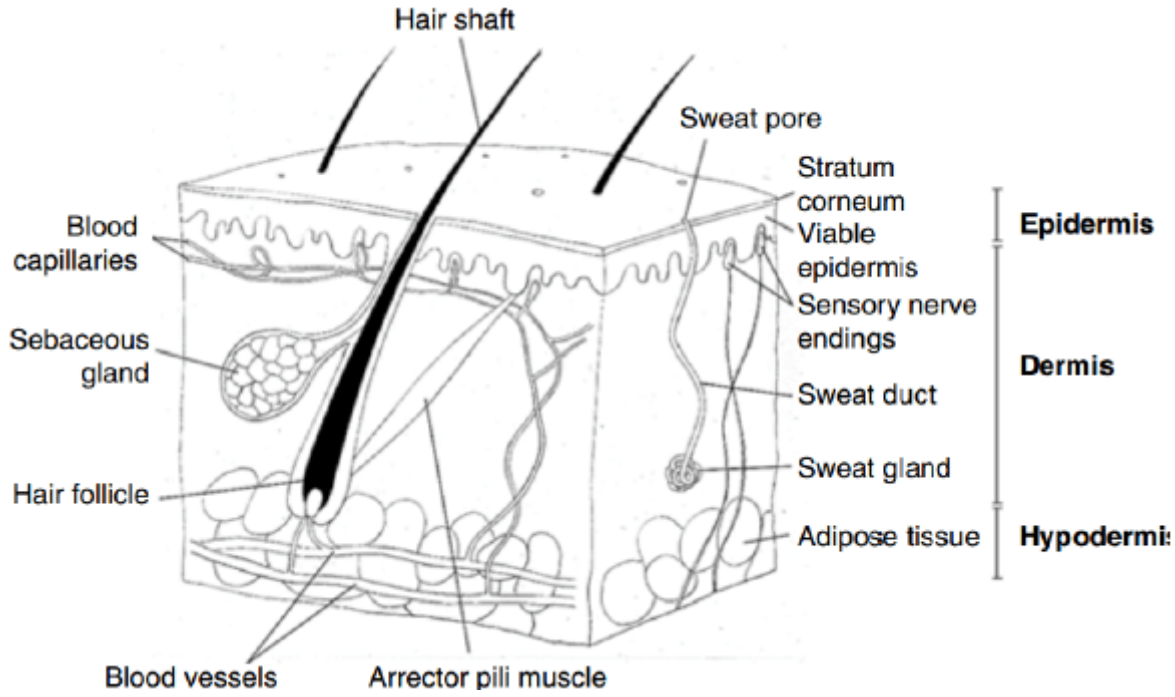
Skin

The skin, the largest organ of the human body, serves as a complex and multifunctional protective barrier between the internal organs and the external environment. Comprising layers of cells, tissues, and appendages, the skin plays a crucial role in maintaining homeostasis and safeguarding the body against physical, chemical, and microbial threats.

The outermost layer, the epidermis, acts as a waterproof shield, preventing excessive loss of fluids and providing protection against harmful UV radiation. Beneath it, the dermis provides structural support, housing blood vessels, nerve endings, and accessory structures such as hair follicles and sweat glands. The subcutaneous tissue, or hypodermis, further insulates the body and stores energy.

Beyond its structural functions, the skin is integral to sensory perception, serving as a conduit for tactile sensations, temperature regulation, and pain perception. It also plays a vital role in immune defense, with specialized cells monitoring and responding to potential threats.

The skin's remarkable regenerative capacity ensures constant renewal, aiding in wound healing and maintaining its protective integrity. Appreciating the skin's complexity highlights its pivotal role in overall health, making it a subject of significant interest in various medical and cosmetic fields.



Epidermis

The epidermis is the **outermost skin** layer of our body. It has many important **functions such as** protecting your body from the outside world, **moisturizing** your **skin,** producing new skin cells and determining your skin color. The epidermis is a **stratified** squamous layer composed **mainly** of two types of **cells,** keratinocytes, and dendritic **cells, with** intercellular bridges and **richly staining** cytoplasm. The epidermis **consists** of five **layers.**

* Stratum Basale.
* Stratum spinosum.
* Stratum granulosum.
* Stratum lucidum.
* Stratum corneum.

The **barrier layer** is the **rate-limiting** barrier **to** transdermal **penetration** of most molecules. It **consists** of 15-20 layers of **keratin-filled** corneocytes **embedded** in **a solid** matrix.

Dermis

The dermis is the second layer of the skin, situated beneath the outermost layer known as the epidermis. Comprising connective tissues, blood vessels, nerves, and various accessory structures, the dermis plays a critical role in providing structural support, sensation, and nourishment to the skin.

Structurally, the dermis is characterized by collagen and elastin fibers that contribute to its strength, flexibility, and resilience. Blood vessels within the dermis supply nutrients and oxygen to the skin cells, facilitating their metabolic functions. Nerve endings in this layer are responsible for the sensations of touch, temperature, and pain.

The dermis houses essential appendages such as hair follicles, sweat glands, and sebaceous glands. Hair follicles give rise to hair, while sweat glands help regulate body temperature through the production of sweat. Sebaceous glands secrete sebum, an oil-like substance that contributes to skin hydration and protection.

Overall, the dermis plays a pivotal role in maintaining the skin's integrity, supporting its various functions, and contributing to the body's overall physiological balance.

Hypodermis

The hypodermis, also known as the subcutaneous tissue or subcutis, is the deepest layer of the skin located beneath the dermis. Composed mainly of adipose (fat) tissue, connective tissue, and blood vessels, the hypodermis serves several essential functions within the body.

One primary function of the hypodermis is to provide insulation and cushioning, helping regulate body temperature by serving as a thermal barrier and protecting internal organs from mechanical shocks. The adipose tissue in the hypodermis also serves as an energy reservoir, storing excess calories for future use.

Blood vessels within the hypodermis play a vital role in regulating temperature by directing blood flow to the skin's surface for cooling or retaining warmth in colder conditions. Additionally, the hypodermis facilitates the diffusion of nutrients and waste products between the skin and underlying tissues.

While not strictly considered part of the skin, the hypodermis is integral to overall skin function and body physiology. Its composition and functions contribute significantly to the body's overall health and well-being.

DRUG PENETRATION ROUTES

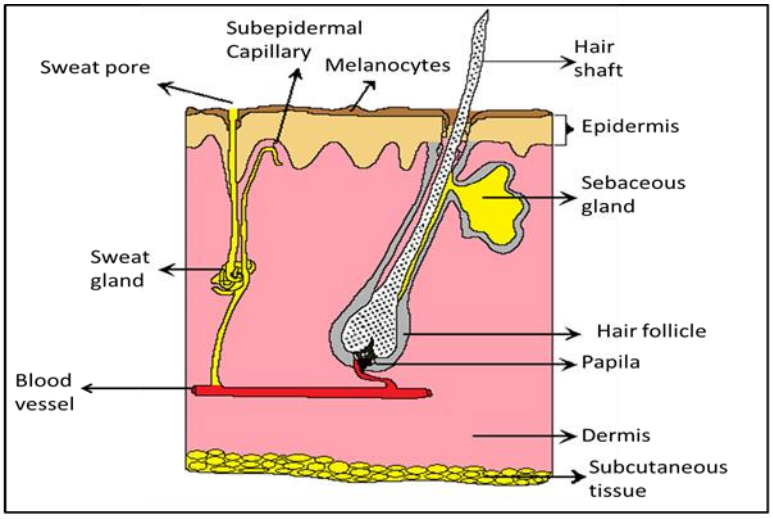
* Trans follicular routes.
* Trans epidermal routes.

TRANS FOLLICULAR ROUTES-

The trans follicular route is a pathway for drug delivery that involves the penetration of substances through hair follicles in the skin. Unlike the more conventional pathways such as the transdermal or oral routes, the trans follicular route capitalizes on the unique structure of hair follicles to facilitate the absorption of drugs.

Hair follicles consist of various layers, including the outer root sheath, inner root sheath, and hair matrix. These structures create a channel through which substances can potentially permeate the skin barrier. The trans follicular route is of particular interest in pharmaceutical research and the development of topical formulations, as it offers an alternative means for drugs to reach systemic circulation or exert local effects.

Researchers are exploring the potential of the trans follicular route to enhance drug delivery efficiency, especially for molecules that face challenges in permeating the skin through conventional routes. This route holds promise for optimizing the delivery of therapeutic agents, cosmetics, and other bioactive compounds, making it a focus of ongoing studies in the field of dermatology and drug formulation.



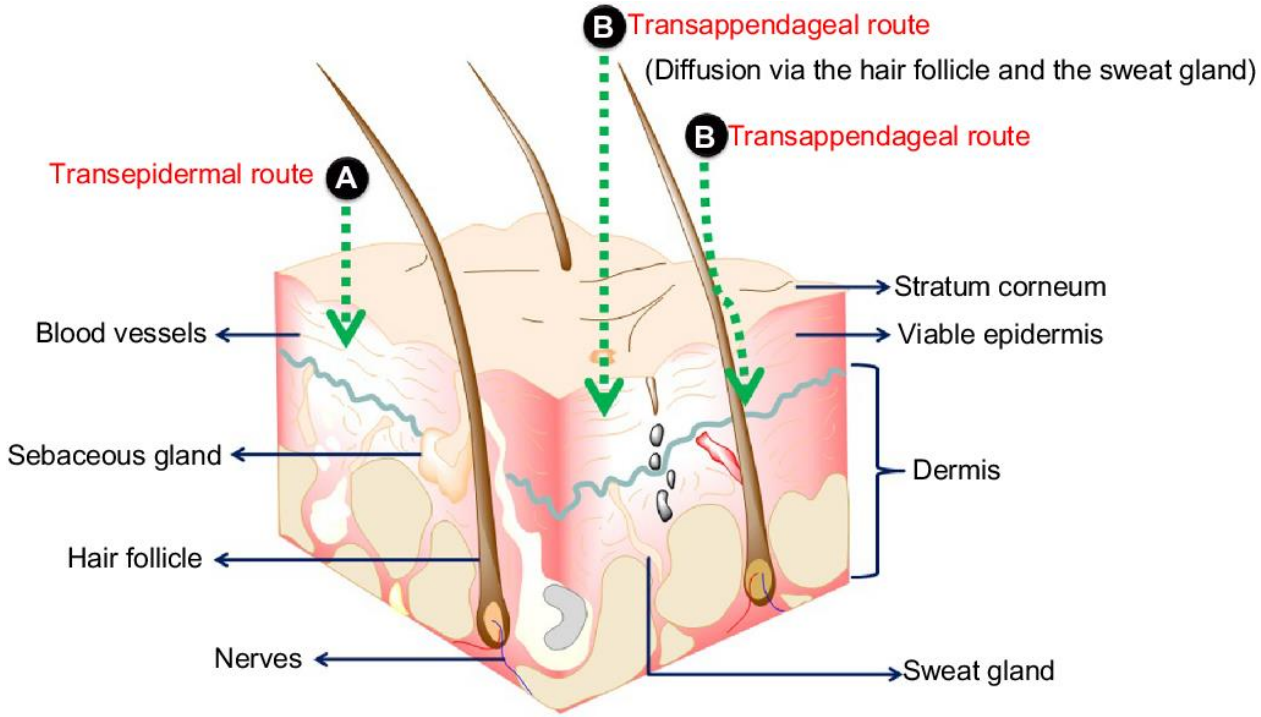
TRANS EPIDERMAL ROUTE

The trans-epidermal route refers to a method of drug delivery that involves the transport of substances across the epidermal layer of the skin. The epidermis, being the outermost layer of the skin, typically poses a formidable barrier to the penetration of most molecules. However, the trans-epidermal route seeks to overcome this barrier, allowing for the absorption of drugs or other active substances directly through the skin.

This route is of particular interest in the field of transdermal drug delivery, where the objective is to transport therapeutic agents across the skin for systemic absorption. Unlike the traditional oral route, trans-epidermal delivery

offers the advantage of bypassing the gastrointestinal tract, potentially reducing side effects and improving drug bioavailability.

Various strategies, such as the use of permeation enhancers or specialized formulations, are employed to facilitate the trans-epidermal transport of substances. This route is essential in the development of transdermal patches, creams, and other topical formulations, contributing to advancements in drug delivery systems and offering alternative options for patient care.



PERMEATION THROUGH SKIN

Absorption is the penetration of substances **into different** layers of **the** skin and **penetration through** the skin **into** the systemic circulation.

Factor affecting of skin permeation

Physiochemical factor:

* Diffusion coefficient
* Partition coefficient
* Skin hydration
* Temperature
* PH
* Drug concentration
* Molecular size and shape
* Solubility and melting point
* Ionization

BIOLOGICAL FACTORS

* Skin condition
* Skin age
* Blood flow
* Skin temperature
* Species difference

BASIC COMPONENT OF TRANSDERMAL DRUG DELIVERY SYSTEM

1 Polymer matrix
2 Membrane
3 Drug
4 permeation enhancers
5 Pressure sensitive adhesive
6 Other excipients.

1 POLYMER MATRIX

A polymer matrix refers to a three-dimensional network or structure formed by polymers, which are large molecules composed of repeating subunits known as monomers. In the context of materials science, a polymer matrix commonly serves as the host or base material in composite materials, where it encapsulates and binds other components, often reinforcing agents like fibers or particles.

In a polymer matrix composite, the polymer matrix provides cohesion, flexibility, and durability to the material, while the reinforcing agents impart specific mechanical, thermal, or electrical properties. The synergy between the polymer matrix and the reinforcing components results in a composite material with enhanced performance characteristics compared to the individual constituents.

The choice of polymer matrix is crucial in determining the overall properties of the composite, as different polymers exhibit varying degrees of strength, elasticity, and resistance to environmental factors. Polymer matrix composites find applications in a wide range of industries, including aerospace, automotive, and construction, where their tailored properties contribute to lightweight, high-strength, and durable materials.

Example

Natural polymer-cellulose derivatives, gelatin waxes etc.

Synthetic elastomers- Silicon rubber, polybutadiene etc.

Synthetic polymer- Polyurea, polyethylene, polyvinyl, chloride, polyvinyl alcohol.

2 MEMBRANE

Basically, the film is used to seal the package surrounding the matrix containing the drug. EXAMPLE- Ethylene vinyl acetate, silicon rubber etc. are used as rate controlling membrane.

3 DRUG

The drug should have following properties:

* Physiochemical properties:

a) **The molecular** weight of the drug **must** be more than 1000 daltons.

b) The drug must have an affinity for the lipophilic and hydrophilic phases.

c) Low melting point.

d) The **pH** of **the** skin is 4.2-5.6, **to avoid skin damage, a** solution in this **pH** range should be **used.**

* **Biological properties:**

a) The drug **must** be **patented** with a daily dose.

b) The medicine must not be irritating or allergic.

EXAMPLE- Captopril, Atenolol, Verapamil hydrochloride etc.

4)PERMEATION ENHANCER

A permeation enhancer is a substance or compound that improves the penetration of drugs or other active ingredients through biological barriers, such as the skin or mucous membranes. The primary function of permeation enhancers is to overcome the natural resistance of these barriers, facilitating the absorption of substances into systemic circulation.

These enhancers work by various mechanisms, such as altering the lipid composition of cell membranes, opening tight junctions between cells, or increasing the solubility of drugs in the membrane. In pharmaceutical and transdermal drug delivery applications, permeation enhancers play a crucial role in enhancing the bioavailability and efficacy of drugs, enabling them to reach therapeutic levels more efficiently.

5)PRESSURE SENSITIVE ADHESIVE

Pressure-sensitive adhesion refers to the unique property of certain materials to adhere to surfaces upon the application of slight pressure. These materials, commonly known as pressure-sensitive adhesives (PSAs), are designed to create an instant bond with surfaces through the application of manual or mechanical pressure. This adhesion is achieved without the need for heat, water, or solvents.

Pressure-sensitive adhesives typically consist of a viscoelastic polymer matrix that adheres to surfaces when pressure is applied, forming a bond upon contact. The adhesive properties are attributed to the combination of viscoelasticity, tackiness, and the ability to flow under low pressure.

These adhesives are widely used in everyday products such as tapes, labels, stickers, and adhesive films. Their convenience and ease of application make them valuable in various industries, including packaging, stationery, and medical applications. Pressure-sensitive adhesion provides a versatile and efficient means of creating temporary or permanent bonds, depending on the formulation and application requirements.

6) OTHER EXCIPIENT

* Solvents- Chloroform, methanol, acetone etc.
* Plasticires- Used for imparting plasticity eg. Polyethylene, glycol, propylene glycol etc.
* Release liner- The trans dermal patch is covered by this liner. Eg. Polyethylene, polyvinylchloride etc.
* Backing film- Backing impart appearances, flexibility and occlusion properties of TDDS.

FORMULATION APPROACHES:

These are those method by which we can formulate TDDs.

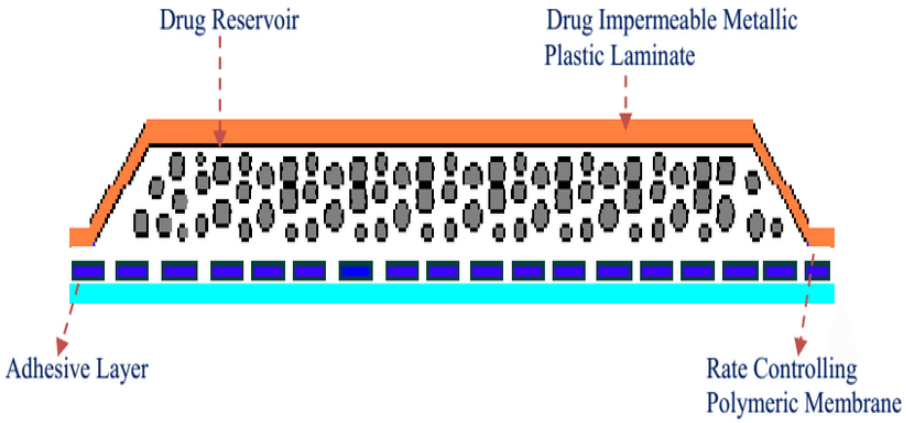
1) Membrane permeation-controlled system.
2) Adhesive dispersion type system
3) Matrix diffusion-controlled system.
4) Micro- reservoir-controlled system

Membrane permeation-controlled system

A membrane permeation-controlled system is a drug delivery approach designed to regulate the release of therapeutic agents over time through a semipermeable membrane. In this system, the membrane acts as a barrier that controls the diffusion of the drug, allowing for a sustained and controlled release.

The drug is typically encapsulated within a reservoir or matrix, and the entire system is enclosed by the semipermeable membrane. As the drug diffuses through the membrane, its release rate is controlled, leading to a prolonged and steady delivery into the surrounding environment or target site.

Membrane permeation-controlled systems find applications in various medical and pharmaceutical contexts, offering advantages such as improved patient compliance, reduced side effects, and enhanced therapeutic efficacy. These systems are particularly valuable in designing drug delivery formulations that require a consistent and controlled release profile over an extended period.



Adhesive diffusion type system –

An adhesive diffusion system is a method of controlled release in drug delivery where a therapeutic substance is released gradually over time through a substrate with adhesive properties. In this system, the adhesive serves a dual purpose by adhering to a surface while also facilitating the diffusion of the active substance.

The drug, often embedded within or coated onto the adhesive matrix, diffuses through the adhesive layer, allowing for a sustained and controlled release of the therapeutic agent. This controlled diffusion provides a consistent and prolonged delivery of the drug, contributing to enhanced therapeutic outcomes and patient convenience.

Adhesive diffusion systems are commonly employed in transdermal patches, where the adhesive layer adheres to the skin, and the drug permeates through the skin barrier. This drug delivery approach is valued for its ability to maintain therapeutic levels of the active substance over an extended period, offering advantages in terms of efficacy and reduced dosing frequency.

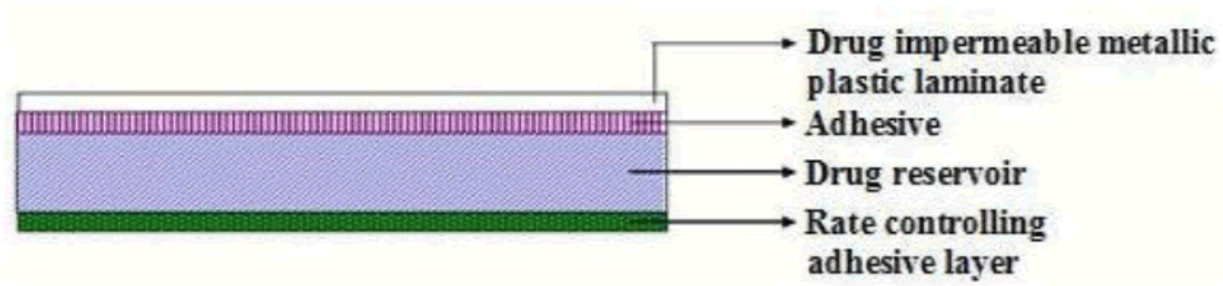
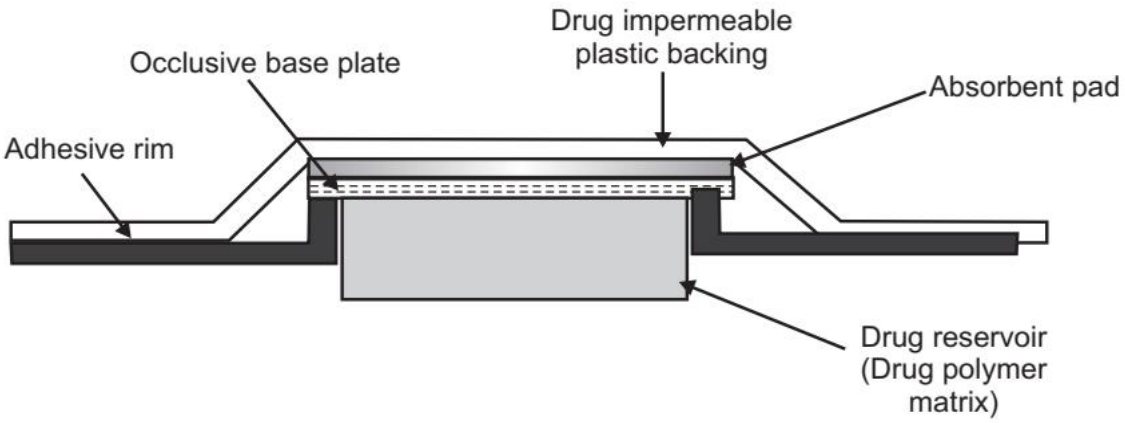


Figure 3: Adhesive dispersion-type system

Matrix diffusion-controlled system

A matrix diffusion-controlled system is a drug delivery mechanism designed to regulate the release of therapeutic substances over time through a matrix or reservoir. In this system, the drug is typically dispersed or encapsulated within the matrix, which can be a polymeric material or other carrier. Matrix diffusion-controlled systems are commonly utilized in pharmaceutical formulations, including oral tablets and implants. These systems offer advantages in terms of maintaining therapeutic concentrations, improving patient compliance, and minimizing fluctuations in drug levels. The design flexibility of matrix diffusion-controlled systems makes them valuable in tailoring drug release profiles for optimal therapeutic outcomes.

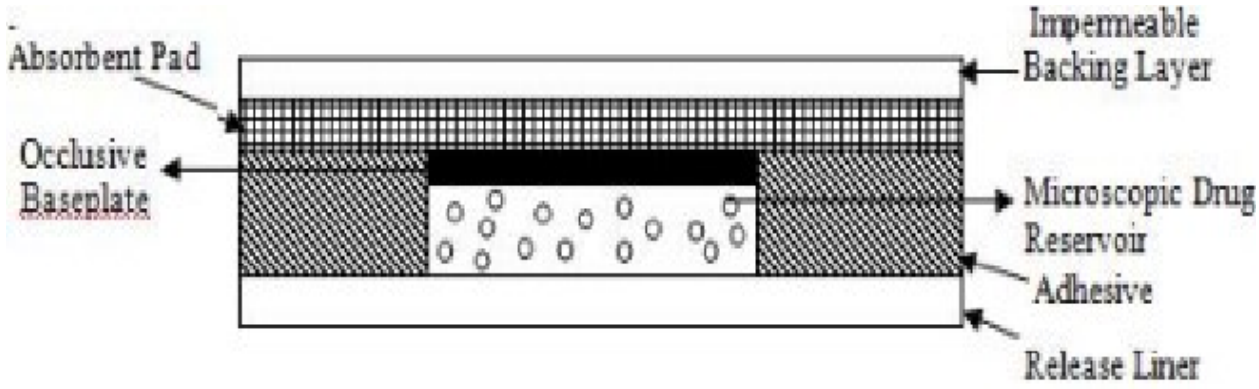


Micro-reservoir- controlled system

A micro-reservoir-controlled system is a drug delivery approach that utilizes micro-reservoirs or compartments within a carrier matrix to regulate the release of therapeutic substances. In this system, the drug is encapsulated in small reservoirs dispersed throughout the matrix, typically made of polymers or other materials.

The release of the drug is controlled by factors such as the size and design of the micro-reservoirs, as well as the properties of the matrix material. As the system interacts with the surrounding environment, the drug is released from the micro-reservoirs in a controlled and sustained manner, contributing to a prolonged therapeutic effect.

Micro-reservoir- controlled systems are commonly employed in various drug delivery applications, including implants, transdermal patches, and oral formulations. This design allows for precise control over release kinetics, optimizing therapeutic outcomes by ensuring a consistent and tailored delivery of the active substance. The versatility of micro-reservoir systems makes them valuable in developing drug delivery solutions with enhanced efficacy and patient convenience.



CONCLUSION

In conclusion, both microencapsulation and transdermal patches stand as innovative and impactful technologies in the realm of drug delivery and therapeutic applications.

Microencapsulation, with its ability to encapsulate active substances within protective coatings, provides a versatile and efficient means to enhance the stability, controlled release, and targeted delivery of drugs. The technology finds applications in pharmaceuticals, food, and cosmetics, offering solutions to challenges related to drug bioavailability, taste masking, and protection of sensitive ingredients. Transdermal patches, on the other hand, represent a revolutionary approach to drug delivery by providing a non-invasive means of administering medications through the skin. These patches offer benefits such as improved patient compliance, reduced side effects, and a consistent release of drugs over an extended period. They have found success in delivering a variety of therapeutic agents, from pain medications to hormonal treatments.

The synergy between microencapsulation and transdermal patches is evident in their shared goal of optimizing drug delivery systems. Microencapsulation techniques contribute to the formulation of active substances in transdermal patches, enhancing their stability and controlled release characteristics.

As research and development in these fields continue, the integration of microencapsulation with transdermal patch technologies holds promising prospects for advancing personalized medicine, improving patient outcomes, and addressing the evolving demands of drug delivery systems. Together, these technologies contribute to the ongoing evolution of pharmaceutical and therapeutic approaches, offering solutions that prioritize effectiveness, convenience, and patient well-being.

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