MICROENCAPSULATION

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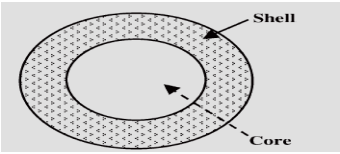
INTRODUCTION

Definition :

Microencapsulation is a process by which solids, liquids or even gases may be enclosed in microscopic particles by formation of thin coatings of wall material around the substances.



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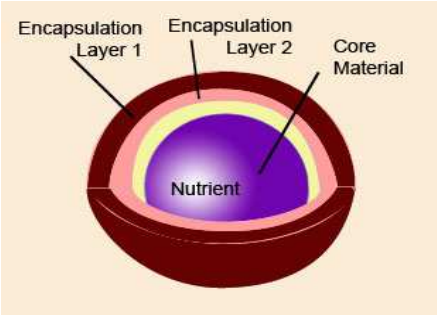

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➢A well designed controlled drug delivery system

- can overcome some of the problems of conventional therapy.

- enhance the therapeutic efficacy of a given drug.

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➢To obtain maximum therapeutic efficacy, drug is to be delivered :

-to the target tissue

-in the optimal amount

-in the right period of time

there by causing little toxicity and minimal side effects.

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- One such approach is using microspheres as carriers for drugs.
- Microspheres are characteristically free flowing powders
- consisting of proteins or synthetic polymers
- biodegradable in nature
- particle size less than 200 µm.

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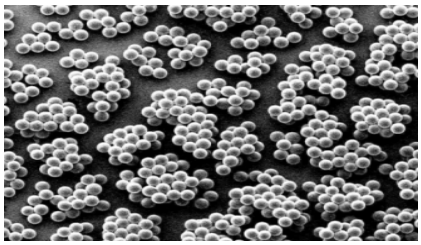
Microspheres:



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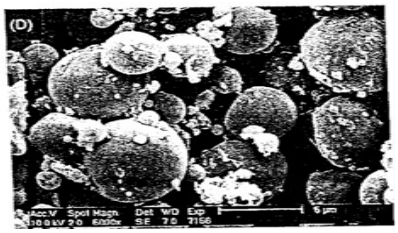

Formulated Microsphere

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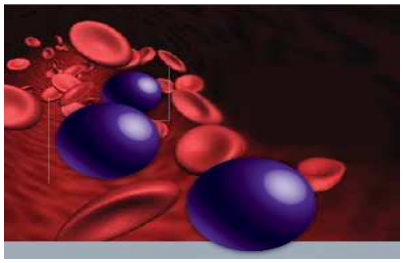

Red one's are R.B.C
Purple one's are microspheres

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REASONS FOR MICROENCAPSULATION

- Isolation of core from its surroundings,

as in isolating vitamins from the deteriorating effects of oxygen.

- retarding evaporation of a volatile core.
- improving the handling properties of a sticky material.

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- isolating a reactive core from chemical attack.
- for controlled release of drugs.
- masking the taste or odor of the core.
- for safe handling of the toxic materials.
- to get targeted release of the drug,

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FUNDAMENTAL CONSIDERATIONS

➢nature of the core and coating materials.

➢the stability and release characteristics of the coated materials.

➢the microencapsulation methods.

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CORE MATERIAL

➢The core material is defined as the specific material to be coated.

➢The core material can be in liquid or solid in nature.

➢The composition of the core material can be varied

-as the liquid core can include dispersed and/or dissolved material.

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➢The solid core can be single solid substance or mixture of active constituents, stabilizers, diluents, excipients and release-rate retardants or accelerators.

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COATING MATERIAL

➢The selection of coating material decides the physical and chemical properties of the resultant microcapsules/microspheres.

➢While selecting a polymer the product requirements should be taken into consideration are:

- stabilization
- reduced volatility
- release characteristics
- environmental conditions, etc.

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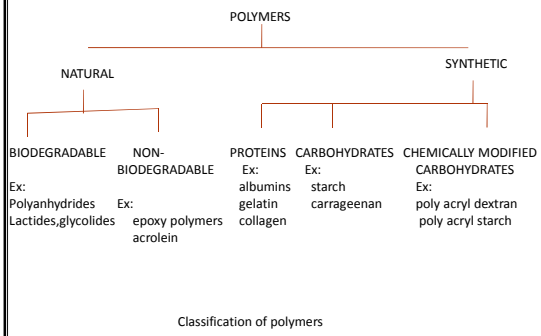

Classification of polymers

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➢The polymer should be capable of forming a film that is cohesive with the core material.

➢It should be chemically compatible, non-reactive with the core material.

➢It should provide the desired coating properties such as:

- strength

-flexibility,

-impermeability,

-optical properties and stability.

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➢Generally hydrophilic / hydrophobic polymers /a combination of both are used for the microencapsulation process.

➢A number of coating materials have been used successfully examples :

-Gelatin

- polyvinyl alcohol

- ethyl cellulose

-cellulose acetate phthalate etc.

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➢The film thickness can be varied considerably depending on:

-the surface area of the material to be coated

-Other physical characteristics of the system.

➢The microcapsules may consist of a single particle or clusters of particles.

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➢After isolation from the liquid manufacturing vehicle and drying, the material appears as a free flowing powder.

➢The powder is suitable for formulation as:

-compressed tablets

-hard gelatin capsules

-suspensions and other dosage forms.

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Morphology of Microcapsules

The morphology of microcapsules depends mainly on the core material and the deposition process of the shell.
1- Mononuclear (core-shell) microcapsules contain the shell around the core.
2- Polynuclear capsules have many cores enclosed within the shell.
3- Matrix encapsulation in which the core material is distributed homogeneously into the shell material.
- In addition to these three basic morphologies, microcapsules can also be mononuclear with multiple shells, or they may form clusters of
microcapsules.

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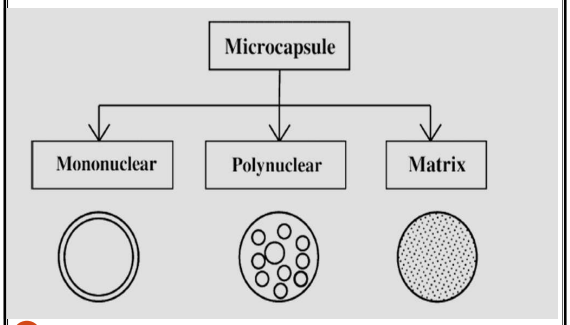

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RELEASE MECHANISMS

➢Even when the aim of a microencapsulation application is the isolation of the core from its surrounding, the wall must be ruptured at the time of use.

➢ A variety of release mechanisms have been proposed for microcapsules :

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➢by pressure or shear stress.

➢by melting the wall.

➢ by dissolving it under particular conditions, as in the case of an enteric drug coating.

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➢by solvent action

➢by enzyme attack

➢by chemical reaction

➢by hydrolysis or slow disintegration.

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METHODS OF PREPARATION

Preparation of microspheres should satisfy certain criteria:

➢The ability to incorporate reasonably high concentrations of the drug.

➢Stability of the preparation after synthesis with a clinically acceptable shelf life.

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➢ Controlled particle size and dispersability in aqueous vehicles for injection.

➢Release of active reagent with a good control over a wide time scale.

➢ Biocompatibility with a controllable biodegradability.

➢Susceptibility to chemical modification.

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MICROENCAPSULATION METHODS

➢ Air suspension

➢ Coacervation phase separation

➢ Multiorifice-centrifugal process

➢ Spray drying and congealing

➢ Pan coating

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➢ Solvent evaporation techniques

➢Electrostatic deposition

➢Vaccum deposition

➢ Polymerization

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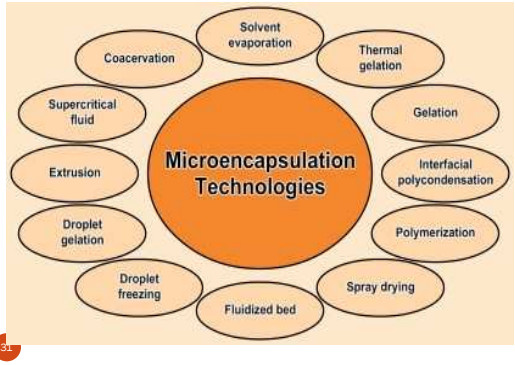

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Microencapsulation process	Nature of the Core material	Approximate particle size(μm)
Air suspension	Solids	35-5000*
Coacervation and phase separation	Solids and Liquids	2-5000*
Multi orifice centrifugation	Solids and Liquids	1-5000*
Pan coating	Solids	600-5000*
Spray drying and congealing	Solids and Liquids	600
Solvent evaporation	Solids and Liquids	5-5000*

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Chemical processes	Physico-chemical processes	Physico-Mechanical process
Interfacial polymerization	Coacervation and phase separation	Spray drying and congealing
In situ polymerization	Sol-gel encapsulation	Fluid bed coating
Poly condensation	Supercritical CO2 assisted microencapsulation	Pan coating
		Solvent evaporation

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AIR SUSPENSION:

- solid, particulate core materials are dispersed in a supporting air stream.
- The coating material is sprayed on the air suspended particles.
- Within the coating chamber, particles are suspended on an upward moving air stream.

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- The design of the chamber and its operating parameters effect a recirculating flow of the particles through the coating zone portion of the chamber, where a coating material, usually a polymer solution, is spray applied to the moving particles.
- During each pass through the coating zone, the core material receives an increment of coating material.

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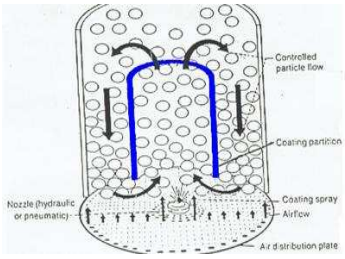

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➢The cyclic process is repeated, perhaps several hundred times during processing, depending on:

-the purpose of microencapsulation

-the coating thickness desired

-Until the core material particles are thoroughly encapsulated.

➢The supporting air stream also serves to dry the product while it is being encapsulated.

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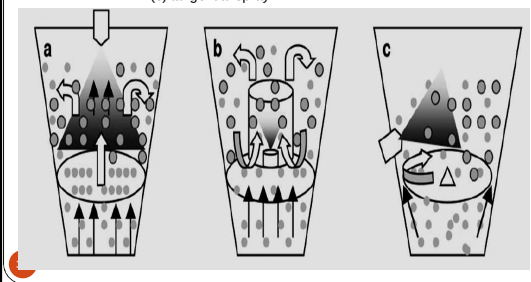
Schematics of a fluid-bed coater.
(a) Top spray;
(b) bottom spray;
(c) tangential spray



➢Drying rates are directly related to the volume temperature of the supporting air stream.

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COACERVATION PHASE SEPARATION

Microencapsulation by coacervation phase separation is generally attributed to The National Cash Register (NCR) Corporation and the patents of B.K. Green et al.

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➢The term originated from the Latin ›acervus‹ , meaning “heap”.

➢This was the first reported process to be adapted for the industrial production of microcapsules.

➢Currently, two methods for coacervation are available, namely simple and complex processes.

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➢ The mechanism of microcapsule formation for both processes is identical, except for the way in which the phase separation is carried out.

➢In simple coacervation a desolvation agent is added for phase separation, whereas complex coacervation involves complexation between two oppositely charged polymers.

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The process consists of three steps:

➢ Formation of three immiscible phases;

▪solvent.

▪a core material phase.

▪a coating material phase.

➢ Deposition of the coating material on the core material.

➢ Rigidizing the coating usually by thermal, cross linking or desolvation techniques to form a microcapsule.

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➢The core material is dispersed in a solution of the coating polymer.

➢The coating material phase, an immiscible polymer in liquid state is formed by

(i) changing temperature of polymer solution

(ii) addition of salt,

e.g. addition of sodium sulphate solution to gelatine solution in vitamin encapsulation ,

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(iii) addition of nonsolvent, e.g. addition of isopropyl ether to methyl ethyl ketone solution of cellulose acetate butyrate (methylscopalamine hydrobromide is core),

(iv) addition of incompatible polymer to the polymer solution, e.g. addition of polybutadiene to the solution of ethylcellulose in toluene (methylene blue as core material),

(v) inducing polymer – polymer interaction, e.g. interaction of gum Arabic and gelatine at their iso-electric point.

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➢Second step, includes deposition of liquid polymer upon the core material.

➢Finally, the prepared microcapsules are stabilized by crosslinking, desolvation or thermal treatment.

➢Crosslinking is the formation of chemical links between molecular chains to form a three-dimensional network of connected molecules.

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➢The vulcanization of rubber using elemental sulfur is an example of crosslinking, converting raw rubber from a weak plastic to a highly resilient elastomer.

➢Chitosan served as an effective cross-linker at pH 7.0, while polyethylenimine (PEI) was used as cross-linker under basic conditions (pH 10.5).

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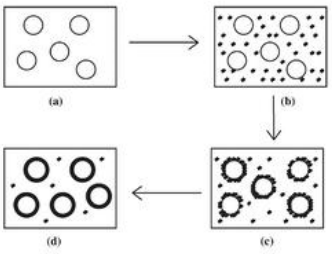

Schematic representation of the coacervation process.
(a) Core material dispersion in solution of shell polymer;
(b) separation of coacervate from solution;
(c) coating of core material by microdroplets of coacervate;
(d) coalescence of coacervate to form continuous shell around core particles.

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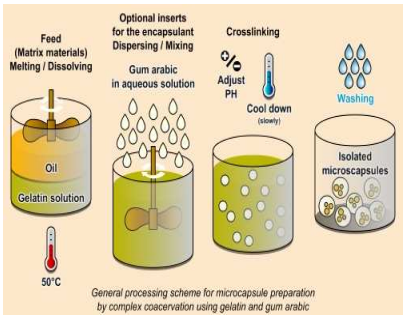

General processing scheme for microcapsule preparation by complex coacervation using gelatin and gum arabic

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Polymer Encapsulation by Rapid Expansion of Supercritical Fluids

➢Supercritical fluids are highly compressed gasses that possess several advantageous properties of both liquids and gases.

➢The most widely used being supercritical carbon dioxide(CO_2), alkanes ($C_2$to C_4), and nitrous oxide (N_2O).

➢A small change in temperature or pressure causes a large change in the density of supercritical fluids near the critical point.

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➢Supercritical CO2 is widely used because of following advantages:

-its low critical temperature value,

-nontoxic,

-non flammable properties;

-readily available,

-highly pure

-cost-effective.

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The most widely used methods are as follows:

•Rapid expansion of supercritical solution (RESS)

•Gas anti-solvent (GAS)

•Particles from gas-saturated solution (PGSS)

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Rapid expansion of supercritical solution

➢Supercritical fluid containing the active ingredient and the shell material are maintained at high pressure and then released at atmospheric pressure through a small nozzle.

➢The sudden drop in pressure causes desolvation of the shell material, which is then deposited around the active ingredient (core) and forms a coating layer.

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➢The disadvantage of this process is that both the active ingredient and the shell material must be very soluble in supercritical fluids.

➢In general, very few polymers with low cohesive energy densities (e.g., polydimethylsiloxanes, polymethacrylates) are soluble in supercritical fluids such as CO2.

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➢The solubility of polymers can be enhanced by using co-solvents.

➢In some cases nonsolvents are used; this increases the solubility in supercritical fluids, but the shell materials do not dissolve at atmospheric pressure.

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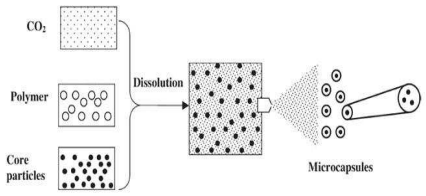

Microencapsulation by rapid expansion of supercritical solutions (RESS).

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Gas anti-solvent (GAS) process

➢This process is also called supercritical fluid anti-solvent (SAS).

➢Supercritical fluid is added to a solution of shell material and the active ingredients and maintained at high pressure.

➢This leads to a volume expansion of the solution that causes super saturation such that precipitation of the solute occurs.

➢The solute must be soluble in the liquid solvent, but should not dissolve in the mixture of solvent and supercritical fluid.

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Particles from a gas-saturated solution (PGSS)

➢This process is carried out by mixing core and shell materials in supercritical fluid at high pressure.

➢During this process supercritical fluid penetrates the shell material, causing swelling.

➢When the mixture is heated above the glass transition temperature (Tg), the polymer liquefies.

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➢Upon releasing the pressure, the shell material is allowed to deposit onto the active ingredient.

➢In this process, the core and shell materials may not be soluble in the supercritical fluid.

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➢The liquid solvent must be miscible with the supercritical fluid.

➢This process is unsuitable for the encapsulation of water-soluble ingredients as water has low solubility in supercritical fluids.

➢It is also possible to produce submicron particles using this method.

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MULTIORIFICE-CENTRIFUGAL PROCESS

➢The Southwest Research Institute (SWRI) has developed this method.

➢ It is a mechanical process for producing microcapsules.

➢centrifugal forces are used to hurl a core material particle through an enveloping microencapsulation membrane.

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➢Processing variables include:

- the rotational speed of the cylinder,
- the flow rate of the core and coating materials,
- the concentration, viscosity, surface tension of the core material.

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➢The multiorifice-centrifugal process is capable for microencapsulating liquids and solids of varied size ranges, with diverse coating materials.

➢The encapsulated product can be supplied as

- slurry in the hardening media
- dry powder.

➢Production rates of 50 to 75 pounds per hour.

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PAN COATING

➢suitable for relatively large particles.

➢solid particles greater than 600 microns in size are generally coated by pan coating.

➢ extensively employed for the Preparation of controlled release beads.

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➢Medicaments are usually coated onto various spherical substrates such as sugar seeds and the coated with protective layers of various polymers.

➢ The coating is applied as a solution or as an atomized spray to the desired solid core material in the coating pan.

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➢Usually, to remove the coating solvent, warm air is passed over the coated materials as the coatings are being applied in the coating pans.

➢In some cases, final solvent removal is accomplished in drying oven.

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CO EXTRUSION

1- A dual fluid stream of liquid core and shell materials is pumped through concentric tubes and forms droplets under the influence of vibration.

2-The shell is then hardened by chemical cross linkings, cooling, or solvent evaporation.

- Different types of extrusion nozzles have been developed in order to optimize the process

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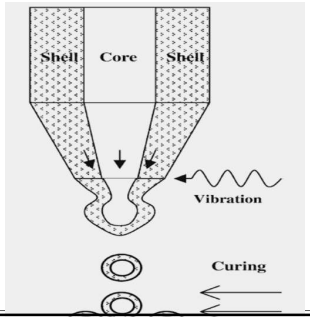
Schematic presentation of the Co-extrusion process



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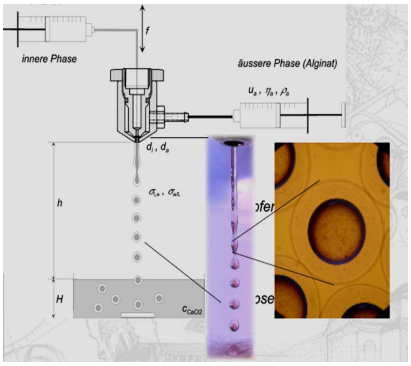

Co-extrusion Process

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SPRAY DRYING AND SPRAY CONGEALING

➢both process involve

-Dispersing the core material in a liquefied coating Substance /spraying or introducing the coating mixture on to core material.

-solidification of coating material

➢The principal difference between the two methods, is the means by which coating solidification is accomplished.

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➢Coating solidification in spray drying is effected by rapid evaporation of a solvent in which the coating material is dissolved.

➢Coating solidification in spray congealing method is accomplished by

-thermally congealing a molten coating material or

-by solidifying a dissolved coating by introducing the coating core material mixture into a nonsolvent.

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➢Removal of the nonsolvent or solvent from the coated product is then accomplished by sorption extraction or evaporation techniques.

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➢Microencapsulation by spray-drying is a low-cost commercial process.

➢ Mostly used for the encapsulation of fragrances, oils and flavours.

➢Core particles are dispersed in a polymer solution and sprayed into a hot chamber.

➢The shell material solidifies onto the core particles as the solvent evaporates such that the microcapsules obtained are of polynuclear or matrix type.

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➢Chitosan microspheres cross-linked with three different cross-linking agents viz,

-tripolyphosphate (TPP),

-formaldehyde (FA)

-gluteraldehyde (GA) have been prepared by spray drying technique.

➢The influence of these cross-linking agents on the properties of spray dried chitosan microspheres was extensively investigated.

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➢The particle size and encapsulation efficiencies of thus prepared chitosan microspheres ranged mainly between 4.1–4.7µm and 95.12–99.17%, respectively.

➢Surface morphology, % erosion, % water uptake and drug release properties of the spray dried chitosan microspheres was remarkably influenced by the type (chemical or ionic) and extent (1 or 2%w/w) of cross-linking agents.

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➢ Spray dried chitosan microspheres cross-linked with TPP exhibited higher swelling capacity, % water uptake, % erosion and drug release rate at both the cross-linking extent (1 and 2%w/w) when compared to those cross-linked with FA and GA.

➢The sphericity and surface smoothness of the spray dried chitosan microspheres was lost when the cross-linking extent was increased from 1 to 2%w/w.

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➢Release rate of the drug from spray dried chitosan microspheres decreased when the cross-linking extent was increased from 1 to 2%w/w.

➢The physical state of the drug in chitosan-TPP, chitosan-FA and chitosan-GA matrices was confirmed by the X-ray diffraction (XRD) study and found that the drug remains in a crystalline state even after its encapsulation.

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➢Release of the drug from chitosan-TPP, chitosan-FA and chitosan-GA matrices followed Fick's law of diffusion.

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➢Spray congealing can be done by spray drying equipment where protective coating will be applied as a melt.

➢Core material is dispersed in a coating material melt rather than a coating solution.

➢Coating solidification is accomplished by spraying the hot mixture into cool air stream.

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➢Waxes, fatty acids, and alcohols, polymers which are solids at room temperature but meltable at reasonable temperature are applicable to spray congealing.

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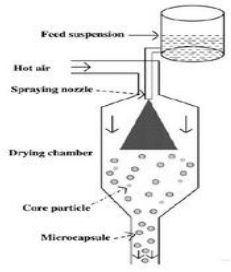

Schematic illustrating the process of micro-encapsulation by spray-drying.

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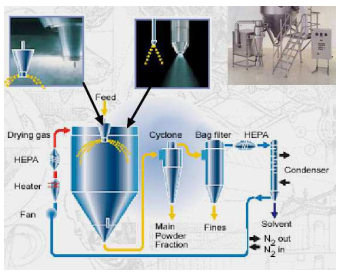

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Spinning Disk

- Suspensions of core particles in liquid shell material are poured into a rotating disc.
- Due to the spinning action of the disc, the core particles become coated with the shell material.
- The coated particles are then cast from the edge of the disc by centrifugal force.
- After that the shell material is solidified by external means (usually cooling).
- This technology is rapid, cost-effective, relatively simple and has high production efficiencies.

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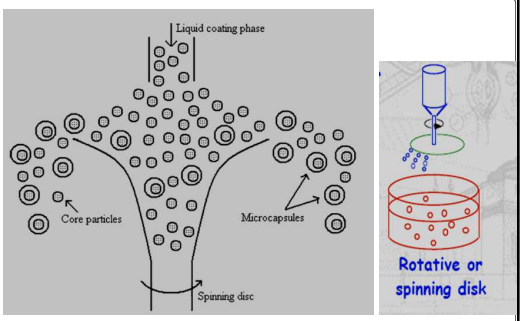

Microencapsulation by spinning disc

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SOLVENT EVAPORATION

- Solvent evaporation techniques are carried out in a liquid manufacturing vehicle (O/W emulsion) which is prepared by agitation of two immiscible liquids.
- The process involves dissolving microcapsule coating (polymer) in a volatile solvent which is immiscible with the liquid manufacturing vehicle phase.
- A core material (drug) to be microencapsulated is dissolved or dispersed in the coating polymer solution.

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- With agitation, the core – coating material mixture is dispersed in the liquid manufacturing vehicle phase to obtain appropriate size microcapsules.
- Agitation of system is continued until the solvent partitions into the aqueous phase and is removed by evaporation.
- This process results in hardened microspheres which contain the active moiety.

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- Several methods can be used to achieve dispersion of the oil phase in the continuous phase.
- The most common method is the use of a propeller style blade attached to a variable speed motor.
- Various process variables include methods of forming dispersions, Evaporation rate of the solvent for the coating polymer, temperature cycles and agitation rates.

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➢Important factors that must be considered in solvent evaporation techniques include choice of

-vehicle phase and

-solvent for the polymer coating.

➢These choice greatly influence microcapsule properties as well as the choice of solvent recovery techniques.

➢The solvent evaporation technique is applicable to a wide variety of liquid and solid core materials.

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➢The core materials may be either water soluble or water insoluble materials.

➢A variety of film forming polymers can be used as coatings.

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ELECTROSTATIC DEPOSITION

➢This method is suitable for both solid and liquid droplets

➢Core and coating material are imparted electric charges by means of high voltage.

➢Core is charged and placed in coating chamber.

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➢Coating material is charged in solution when it leaves the atomizer device prior to spray as a mist.

➢Since both are oppositely charged coating material gets deposited on core due to electrostatic attraction.

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VACCUM DEPOSITION

➢This is not a popular technique.

➢Coating material is vapourised in chamber in which core material is present.

➢Coating material gets deposited on core particles.

➢Core particles are moved on conveyor system and they encounter hot vapours of coating material Which gets deposited on them

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POLYMERIZATION

➢A relatively new microencapsulation method utilizes polymerization techniques to form protective microcapsule.

➢The methods involve the reaction of monomeric units located at the interface existing between a core material substance and a continuous phase in which the core material is dispersed.

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Interfacial polymerization (IFP)

- The capsule shell will be formed at the surface of the droplet or particle by polymerization of the reactive monomers.
- The substances used are multifunctional monomers.
- Generally used monomers include multifunctional isocyanates and multifunctional acid chlorides.
- These will be used either individually on in combination.

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- The multifunctional monomer dissolved in liquid core material
- it will be dispersed in aqueous phase containing dispersing agent.
- A coreactant multifunctional amine will be added to the mixture.
- This results in rapid polymerization at interface and generation of capsuleshell takes place.

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- A polyurea shell will be formed when isocyanate reacts with amine,
- polynylon or polyamide shell will be formed when acid chloride reacts with amine.
- When isocyanate reacts with hydroxyl containing monomer produces polyurethane shell.

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In situ polymerization

- Like IFP the capsule shell formation occurs because of polymerization of monomers.
- In this process no reactive agents are added to the core material.
- polymerization occurs exclusively in the continuous phase and on the continuous phase side of the interface formed by the dispersed core material and continuous phase.

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- Initially a low molecular weight prepolymer will be formed, as time goes on the prepolymer grows in size.
- it deposits on the surface of the dispersed core material there by generating solid capsule shell.

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APPLICATIONS OF MICROENCAPSULATION

The technology has been used widely in the design of controlled release and sustained release dosage forms.

- To mask the bitter taste of drugs like Paracetamol, Nitrofurantoin etc.
- to reduce gastric and other G.I. tract irritations.

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▪Sustained release Aspirin preparations have been reported to cause significantly less G.I. bleeding than conventional preparations.

➢A liquid can be converted to a pseudo-solid for easy handling and storage. eg.Eprazinone.

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➢ Hygroscopic properties of core materials may be reduced by microencapsulation e.g. Sodium chloride.

➢Carbon tetra chlorides and a number of other substances have been microencapsulated to reduce their odour and volatility.

➢ Microencapsulation has been employed to provide protection to the core materials against atmospheric effects, e.g.Vit.A.Palmitate.

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➢ Separation of incompatible substance has been achieved by encapsulation.

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PHYSICOCHEMICAL EVALUATION

CHARACTERIZATION:

➢The characterization of the microparticulate carrier is important, which helps to design a suitable carrier for the proteins, drug or antigen delivery.

➢These microspheres have different microstructures.

➢These microstructures determine the release and the stability of the carrier.

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SIEVE ANALYSIS

➢Separation of the microspheres into various size fractions can be determined by using a mechanical sieve shaker.

➢A series of five standard stainless steel sieves (20, 30, 45, 60 and 80 mesh) are arranged in the order of decreasing aperture size.

➢Five grams of drug loaded microspheres are placed on the upper-most sieve.

➢The sieves are shaken for a period of about 10 min, and then the particles on the screen are weighed.

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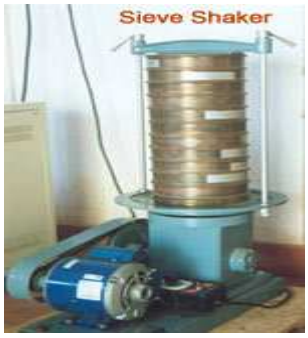

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MORPHOLOGY OF MICROSPHERES

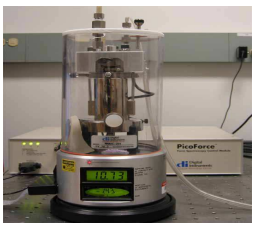
➢The surface morphologies of microspheres are examined by a scanning electron microscope.

109

ATOMIC FORCE MICROSCOPY (AFM)

➢A Multimode Atomic Force Microscope form Digital Instrument is used to study the surface morphology of the microspheres.

110



Atomic Force Microscope

111

PARTICLE SIZE

➢Particle size determination:

▪approximately 30 mg microparticles is redispersed in 2–3 ml distilled water, containing 0.1% (m/m) Tween□ 20 for 3 min, using ultrasound.

▪then transferred into the small volume recirculating unit, operating at 60 ml/ s.

➢The microparticle size can be determined by laser diffractometry.

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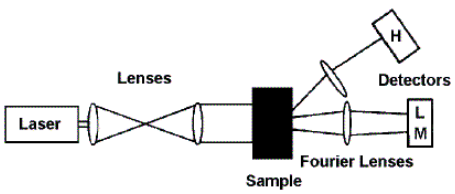
laser diffractometer.

113



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POLYMER SOLUBILITY IN THE SOLVENTS

- Solution turbidity is a strong indication of solvent power .
- The cloud point can be used for the determination of the solubility of the polymer in different organic solvents.

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VISCOSITY OF THE POLYMER SOLUTIONS

- The absolute viscosity, kinematic viscosity, and the intrinsic viscosity of the polymer solutions in different solvents can be measured by a U-tube viscometer.
- The polymer solutions are allowed to stand for 24 h prior to measurement to ensure complete polymer dissolution.

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117 viscometer

DENSITY DETERMINATION

- The density of the microspheres can be measured by using a multi volume pychnometer.
- Accurately weighed sample in a cup is placed into the multi volume pychnometer.
- Helium is introduced at a constant pressure in the chamber and allowed to expand. This expansion results in a decrease in pressure within the chamber.

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- Two consecutive readings of reduction in pressure at different initial pressure are noted.
- From two pressure readings the volume and density of the microsphere carrier is determined.

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120 multi volume pychnometer.

BULK DENSITY

- The microspheres fabricated are weighed and transferred to a 10-ml glass graduated cylinder.
- The cylinder is tapped until the microsphere bed volume is stabilised.
- The bulk density is estimated by the ratio of microsphere weight to the final volume of the tapped microsphere bed.

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CAPTURE EFFICIENCY

- The capture efficiency of the microspheres or the percent entrapment can be determined by allowing washed microspheres to lyse.
- The lysate is then subjected to the determination of active constituents as per monograph requirement.
- The percent encapsulation efficiency is calculated using equation:

% Entrapment = Actual content/Theoretical content x 100

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ANGLE OF CONTACT

- The angle of contact is measured to determine the wetting property of a micro particulate carrier.
- To determine the nature of microspheres in terms of hydrophilicity or hydrophobicity.
- This thermodynamic property is specific to solid and affected by the presence of the adsorbed component.

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- The angle of contact is measured at the solid/air/water interface.
- The advancing and receding angle of contact are measured by placing a droplet in a circular cell mounted above objective of inverted microscope.

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IN VITRO METHODS

- There is a need for experimental methods which allow the release characteristics and permeability of a drug through membrane to be determined.
- For this purpose, a number of *in vitro and in vivo techniques* have been reported.
- *In vitro drug release* studies are employed as a quality control procedure in pharmaceutical production, in product development etc.

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➢The influence of technologically defined conditions and difficulty in simulating *in vivo conditions has led to* development of a number of *in vitro release* methods for buccal formulations; however no standard *in vitro method has yet been* developed.

➢Different workers have used apparatus of varying designs and under varying conditions, depending on the shape and application of the dosage form developed

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BEAKER METHOD

➢The dosage form in this method is made to adhere at the bottom of the beaker containing the medium and stirred uniformly using over head stirrer.

➢Volume of the medium used in the literature for the

-studies varies from 50- 500 ml

-stirrer speed form 60-300 rpm.

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DISSOLUTION APPARATUS

➢Standard USP or BP dissolution apparatus have been used to study *in vitro release* profiles.

➢Dissolution medium used for the study varied from 100-500 ml and speed of rotation from 50-100 rpm.

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ADVANTAGES

➢ Reliable means to deliver the drug to the target site with specificity.
➢The desired concentration can be maintained at the site of interest without untoward effects .
➢ Solid biodegradable microspheres have the potential for the controlled release of drug.
➢ Microspheres received much attention for targeting of anticancer drugs to the tumour.
➢The size, surface charge and surface hydrophilicity of microspheres are found to be important in determining the fate of particles *in vivo*.
➢ Studies on the macrophage uptake of microspheres have demonstrated their potential in targeting drugs to pathogens residing intracellularly.

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CONCLUSION

The microencapsulation technique offers a variety of opportunities such as

➢Protection.
➢Masking.
➢reduced dissolution rate.
➢facilitation of handling.
➢targeting of the active ingredient.
➢facilitates accurate delivery of small quantities of potent drugs.
➢reduced drug concentrations at sites other than the target organ or tissue.
➢protection of labile compounds before and after administration and prior to appearance at the site of action.
➢In future by combining various other approaches, microencapsulation technique will find the vital place in novel drug delivery system.

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EXAMPLES OF SOME MICROENCAPSULATED DRUGS [2]

Drug / Core material	*Characteristic property*	*Purpose of encapsulation*	*Final product form*
Actaminophen	Slightly water soluble solid	Taste masking	Tablet
Aspirin	Slightly water soluble solid	Taste masking, sustained release, reduced gastric irritation, separation of incompatibles	Tablet or capsule
Islet of Langerhans	Viable cells	Sustained normalization of diabetic condition	Injectable
Isosorbide dinitrate	Water soluble solid	Sustained release	Capsules
Menthol	Volatile solution	Reduction of volatility, sustained release	Lotion
Progesterone	Slightly water soluble solid	Sustained release	Varied
Potassium chloride	Highly water soluble solid	Reduced gastric irritation	Capsule
Urease	Water soluble enzyme	Permselectivity of enzyme, substrate, and reaction products.	Dispersion
Vitamin A palmitate	Nonvolatile liquid	Stabilization to oxidation	Dry powder

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MICROENCAPSULATION PROCESSES AND THEIR APPLICABILITES [29]

#	Method Name	Applicable Material	Particle Size	Production Scale	Process reproducibility and Consistency	Time required for preparation	Cost Factor	Operation Skill required
1	Air Suspenstion	Solids	35 - 5000	Pilot Scale	Moderate	High	High	High
2	Co - acervation and Phase Separation	Solids & Liquids	2 - 5000	Lab Scale	Good	Less	Less	Less
3	Multiorifice Centrifugal	Solids & Liquids	1 - 5000	Pilot Scale	Moderate	High	High	High
4	Pan Coating	Solids	600 - 5000	Pilot Scale	Moderate	High	High	High
5	Solvent Evaporation	Solids & Liquids	5 - 5000	Lab Scale	Good	Less	Less	Less
6	Spray Drying and Spray Congealing	Solids & Liquids	600	Pilot Scale	Moderate	High	High	High

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Thank you

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