VOBIS, LLC MICROENCAPSULATION PROCESSES

WHY MICROENCAPSULATION?

- Isolation of Active Ingredient from External Environment
- Aroma Masking
- Time Delayed Release of Active
- Controlled Delivery of Active in Process
- Taste Masking
- Moisture Protection
- Oxidation Protection

WHY MICROENCAPSULATION?

- Nondusting Ingredient Delivery
- Metering of Ingredients
- Marketing Appeal – Spheres, Shapes

VOBIS PROCESSES INCLUDE

- Extrusion/Spheronization
- Spray Chilling
- Drip Forming
- High Pressure Shockwave
- Fluid Bed Granulation and Coating
- Pelleting
- Spray Drying

VOBIS PROCESSES INCLUDE

- Complex Coacervation
- High Sheer Melt Granulation
- Melt Spray Granulation

VOBIS PROCESSES

- Utilize Experience with Hundreds of Shells
- Fully Scalable from Bench to Production
- Can be Compliant for GMP, FDA, Pharma, Food, Chemical, Industrial Requirements

VOBIS MICROENCAPSULATION METHODS

- Microencapsulation in Aqueous Media
- Microencapsulation Using Hot Melt with Fats/Waxes
- Microencapsulation for Volatile Liquids
- Microencapsulation for Gasses
- Microencapsulation with Food and Industrial Shells including Crosslinked Polymers

CONTROLLED RELEASE MICROENCAPSULATION

COMMON EXAMPLES

- Regulate Release Over Time
- Isolate Active Until Triggered
- Increase Efficiency of Use
- Reduce Handling/Environmental Hazards
- Increase Size
- Increase Shelf Life
- Mask Taste/Odor
- Convert a Liquid/Gas to a Solid

- Contac™
- Carbonless Paper
- Pharmaceuticals
- Pesticides – WDG/WSG

- Seeds
- Vitamins in Foods
- Warfarin
- Kitty Litter

CONTROLLED RELEASE MICROENCAPSULATION

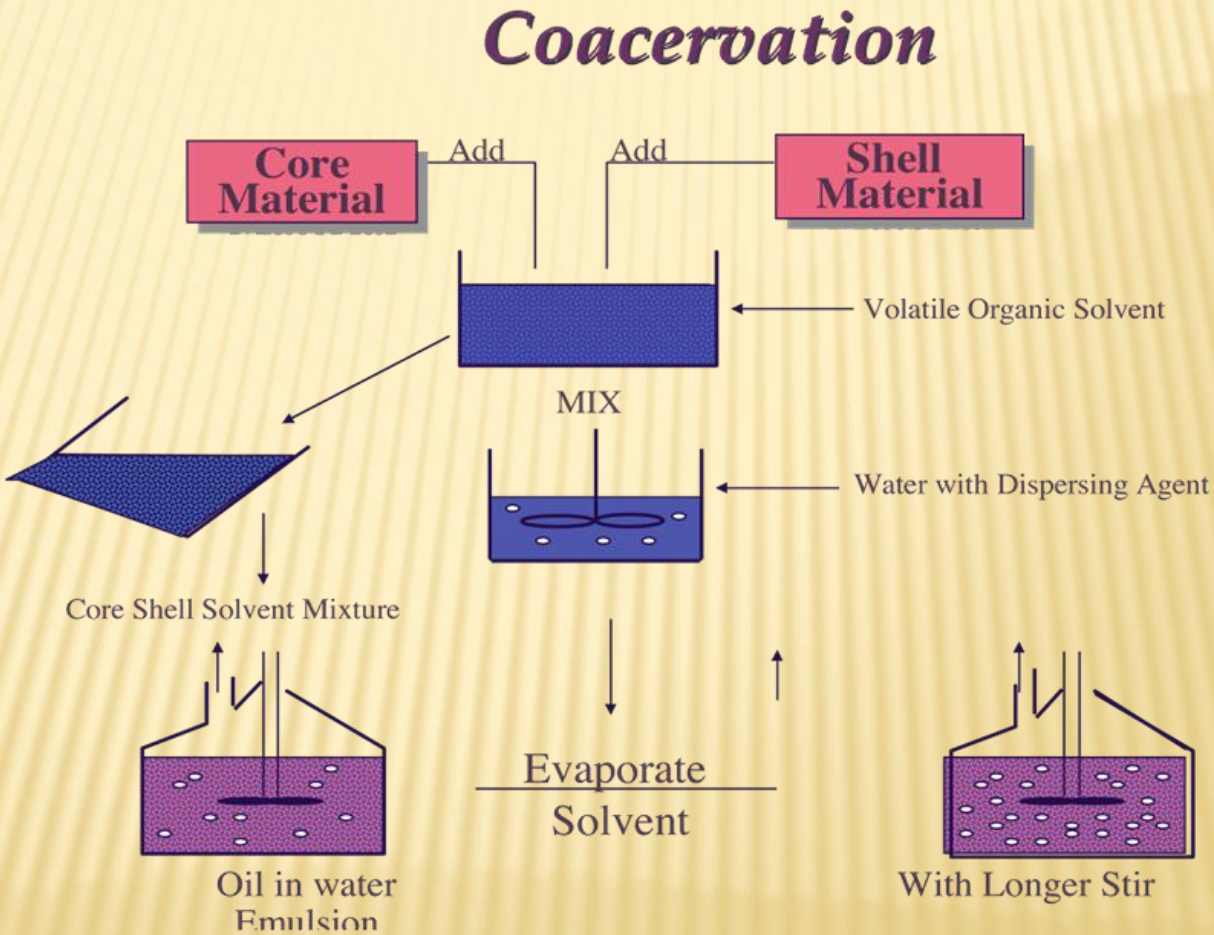
Release Mechanisms

- Diffusion
- Mechanical, Pressure, Sheer, Ultrasonic
- Temperature
- pH
- Enzymatic
- Light/Radiation

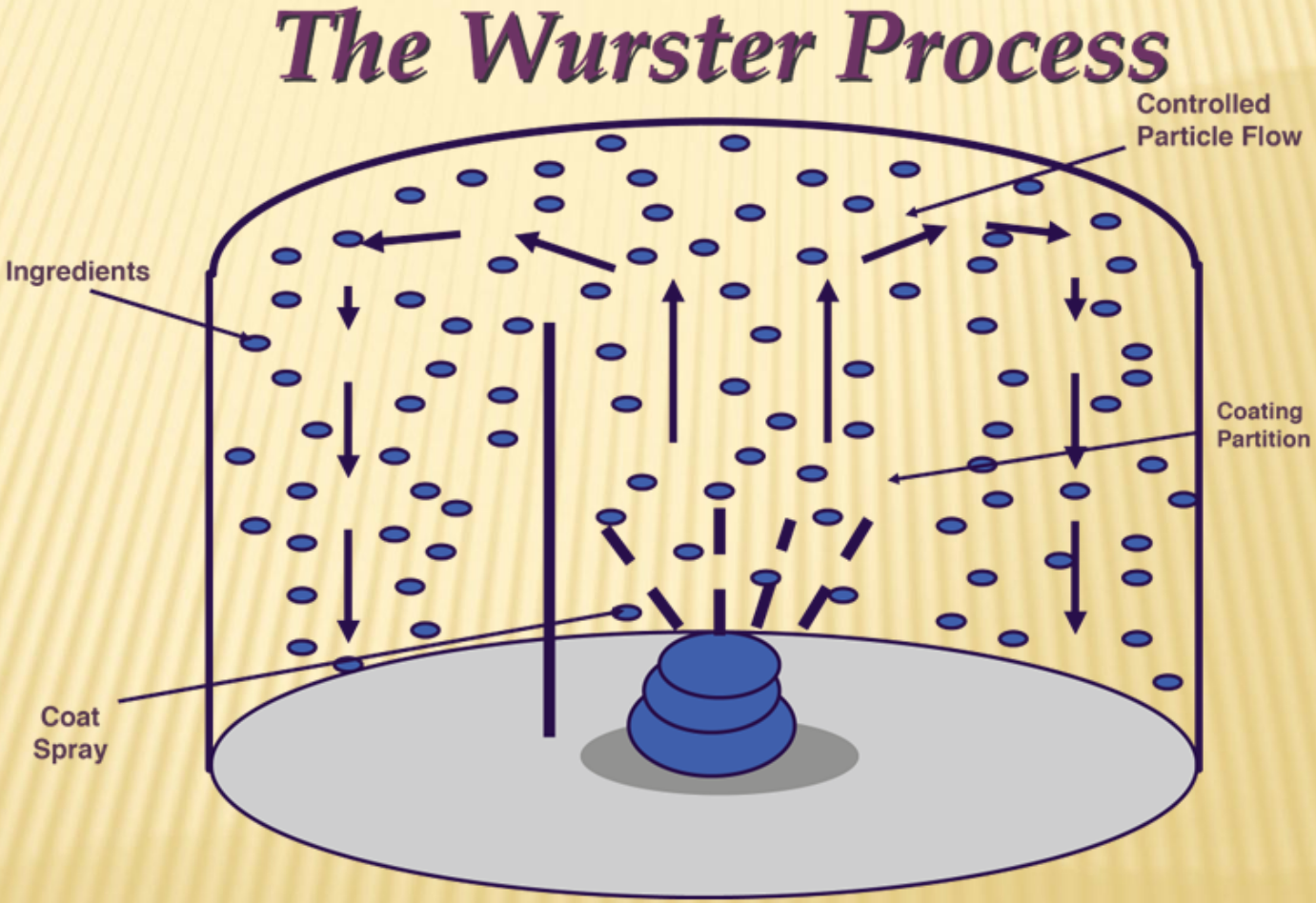
Rate Controlling Factors

- Shell Material and Integrity
- Shell Thickness and the Use of Multiple Shell Layering
- Capsule Size
- Host Material Interaction

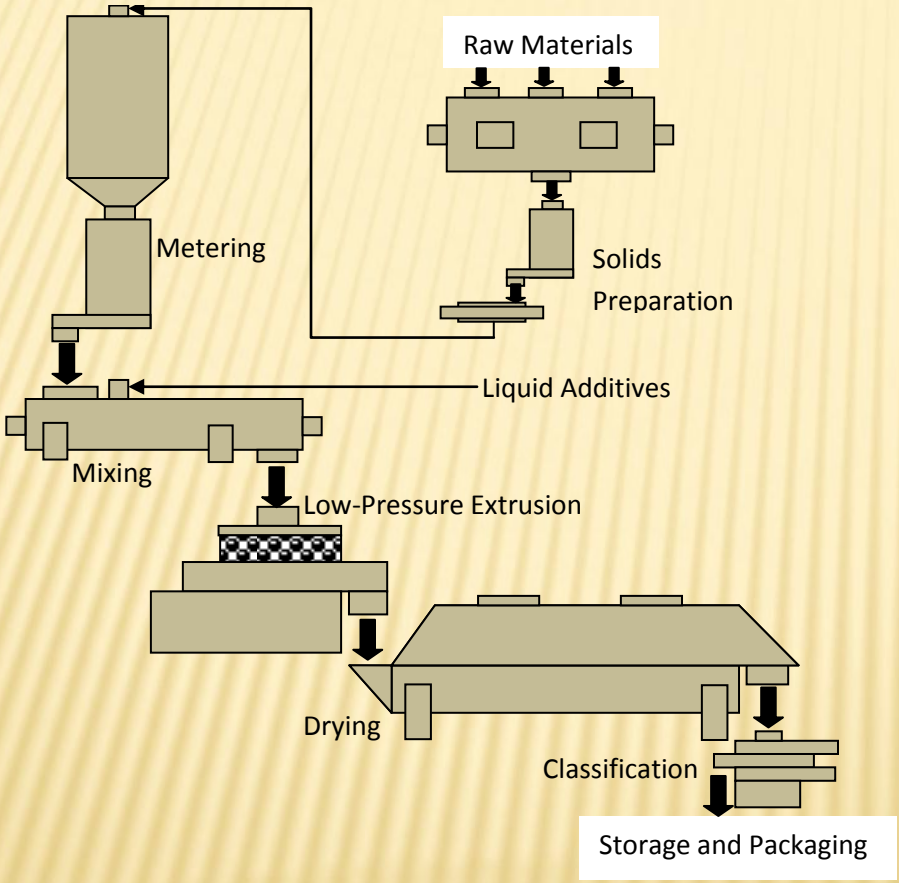
COACERVATION



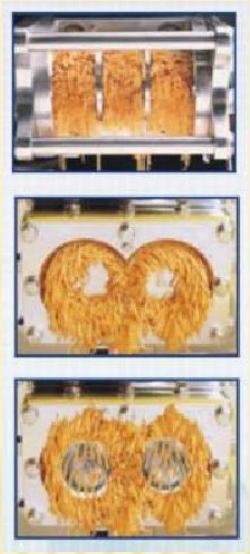
WURSTER PROCESS

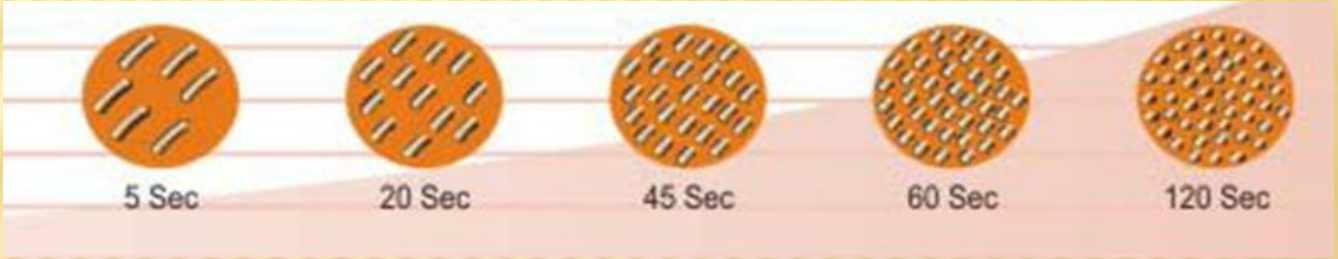


EXTRUSION PROCESS



EXTRUSION/SPHERONIZATION





DRIP MICROENCAPSULATION

- Small sample size needed for initial studies
- Narrow size distribution
- Forms Seamless matrix spheres
- Data is scalable to production
- capacities
- GMP design
- Controlled release spheres
- Wide range of shell/matrix materials includes:
  alginate, gelatin, agar,
  starch, cellulose sulfate, waxes,
  thermoplastics, and various polymers

VOBIS METHODS CONSIDERATIONS FOR CHOICE OF BEST APPROACH

- Batch Coacervation Requires Extensive Period of Agitation and has Problems in Size Control
- Continuous Coacervation is fully scalable
- Interfacial Polymerization Requires Use of Solvents and Suffers Inability in Shell Thickness Control
- Wurster and Fluid Bed Processes Allow Diverse Coatings - Melt, Solvents, and Water Based, but is Batch
- Spray Drying Provides Wide Size Distribution, Water or Solvent Based, Can Create to Much Heat History for Shell and Active
- Nonvibrational Drip Forming is Limited to Matrix Spheres Formation, Has Narrow Size Distribution
- Pellet Mill Only for Larger Pellets of 1 mm, Creates Sturdy Pellets
- Extrusion and Spheronization Provides High Active Load, Narrow Size Distribution, Control of Release with Axial, Radial and Basket Designs

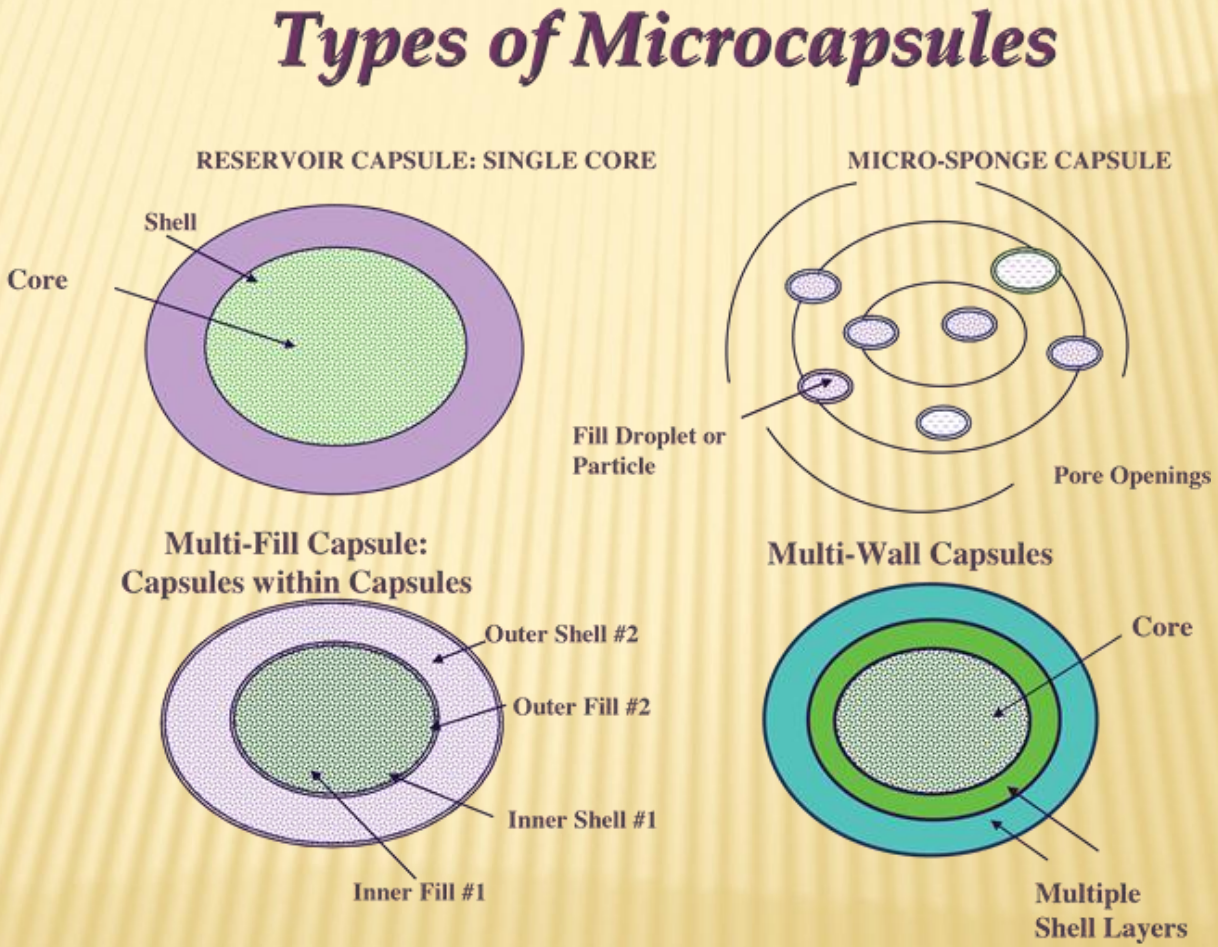
MICROENCAPSULATION: FINAL SIZES

PROCESS	CORE MATERIAL	SIZE(Micron)
Coacervation	Solids/Liquids	10-500
Air Suspension	Solids	50-5000
Spray Coating	Solids/Liquids	5-500
Pan Coating	Solids	500-5000
Shockwave	Solids/Liquids/Gases	0.1-800
Extrusion/Spheronization	Solids/Liquids	500-3500
Pelleting	Solids/Liquids	1000-15000
Drip	Solids/Liquids	250-4000

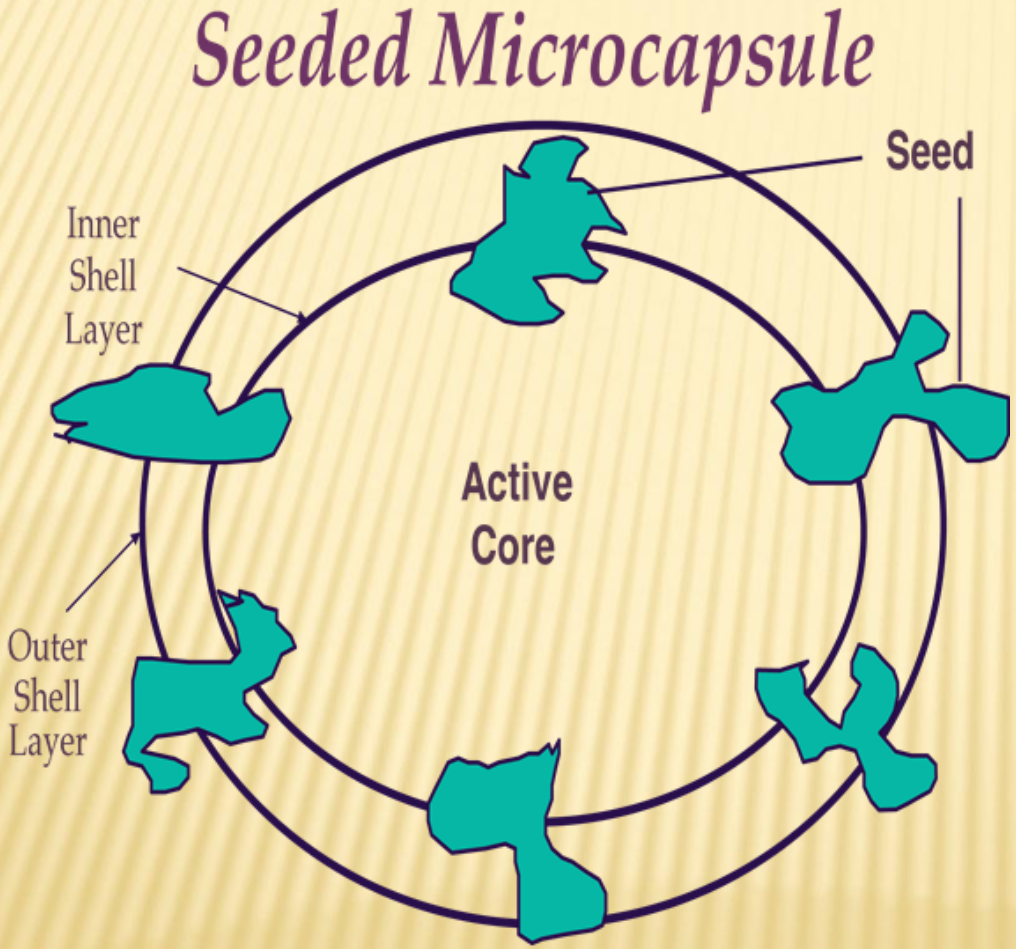
MICROCAPSULE CONSTRUCTS

- **Reservoir Microcapsules:** Single Shell with Typical Load of 70% Active
- **Micro-Sponge Microcapsules:** Typical Load 20% Active
- **Multi-Core Microcapsules:** Capsule Inside of Capsule
- **Multi-Shell Microcapsules:** Multiple Shell Layers
- **Seeded Microcapsules:** Shell has Seeds Imbedded for Strength or Specific Release'
- **Liquid Core Microcapsules:** Liquids Entrapped in Wax Substrate
- **Absorbent Microcapsules:** Active is Absorbed onto Particle and then Coated. Very Narrow Size Distribution
- **Matrix Microcapsules:** to 95% Active Load Depending on Method

TYPES OF MICROCAPSULES



SEEDED MICROCAPSULES



MICROENCAPSULATION TECHNOLOGIES

Microencapsulation Processes

- Highly Efficient and Cost Effective
- Ability to Encapsulate Difficult Compounds
- Encapsulating Liquids, Gasses, and Solids
- Narrow Capsule or Wide Capsule Size Distribution
- Narrow Shell Thickness
- Wide Size Range Capabilities from sub Micron to Over Half an Inch
- Structural Integrity for Tableting, Chewing Resistence
- Easily Dispersed or Dissolved for WDG/WSG Applications

VOBIS ADVANTAGES

- Ability to Make Small Capsules
- Capsules Formed in a Liquid Media, Water or Solvent
- Capsules Formed Dry
- Multiple Shell Layering
- Experienced with Hundreds of Shell Materials
- Ability to Make Large Pellets
- Ability to Control Physical Sturdiness
- Ability to Produce Narrow Size Distribution
- Coating Methodology Often Results in Very Dense Shell Structures, Offering a Slow Release Profile, a Better Barrier for the Shell Material and Extended Release Applications
- Fully Scalable Processes

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