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| 11 | رقم المحاضرة |
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| Sprowel's American Pharmacy. | |
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محتوى المحاضرة

Definition

An emulsion is a thermodynamically unstable dispersion in which the dispersed phase is composed of small globules of a liquid distributed throughout a vehicle in which it is immiscible.

- Dispersed phase = internal phase
- Dispersion medium = external / continuous phase

To prepare a stable emulsion, a third phase (emulsifying agent) is required as stabilizer.

Most emulsions have droplet sizes 0.1–100 μm and are inherently unstable systems.

Types of Emulsions

1. Oil-in-water (o/w): oleaginous internal phase, aqueous external phase.
2. Water-in-oil (w/o): aqueous internal phase, oleaginous external phase.

- o/w can be diluted with water; w/o with oil.
- Multiple emulsions: e.g. w/o/w, o/w/o, used for delayed-release delivery.

By physical state

- Liquid emulsions
- Semi-solid emulsions

By route of administration

- Oral: o/w (e.g., castor oil emulsion)
- Topical: lotions, creams, liniments
- Parenteral: I.V. (o/w), I.M. / S.C. (w/o)

Choice between o/w and w/o depends on:

- Nature of drug
- Desired effect
- Route of administration

Microemulsions vs. Macroemulsions

- Microemulsions form spontaneously by mixing oil + water with surfactants.
- Droplet sizes: 100–1,000 Å (much smaller than macroemulsions ~5,000 Å).
- Can be o/w or w/o depending on components.

Advantages of microemulsions:

1. Enhance oral drug absorption.
 2. Improve transdermal delivery.
 3. Small droplet size promotes skin penetration.
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Identification of Emulsion Type

1. Miscibility test
 - o/w mixes with water; w/o mixes with oil.
 2. Filter paper test
 - o/w spreads rapidly on paper.
 3. Conductivity test
 - o/w conducts electricity (lamp glows), w/o does not.
 4. Dye solubility test
 - o/w evenly colors with water-soluble dye; w/o with oil-soluble dye.
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Purpose & Benefits

1. Enables stable, homogeneous mixtures of immiscible liquids.
 2. Oral: masks taste of oils (e.g., castor oil).
 3. Parenteral:
 - I.V. o/w emulsions → nutrition, vitamins.
 - I.M./S.C. w/o emulsions → prolonged action.
 4. Topical:
 - o/w easier to wash off, less irritating.
 - w/o more emollient, protective, resist drying.
 5. Small internal globules enhance percutaneous absorption.
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Acceptable Emulsion Characteristics

- Uniform distribution of globules.
- Pleasant appearance/texture.

- Suitable flavor (oral).
 - Easy to spread (topical).
 - Physical stability (no flocculation, creaming, cracking).
 - Microbiological stability.
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Disadvantages

1. Thermodynamically unstable → need stabilizers.
 2. Must be shaken before dosing.
 3. Accuracy of dosing lower than solutions.
 4. Storage may cause creaming/cracking.
 5. Risk of microbial contamination.
 6. Bulkier than solids.
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Gibbs Free Energy

$$\Delta G = \Delta A \gamma$$

- A = total surface area of droplets.
- γ = interfacial tension.

Stable emulsions: large A , small G .

Achieved by decreasing γ with emulsifiers.

Theories of Emulsification

1. Surface tension theory
 - Liquids minimize surface area → spheres.
 - Surfactants lower interfacial tension → stabilize small droplets.
2. Oriented wedge theory

- Emulsifier forms monomolecular layer around droplets.
- Hydrophilic emulsifiers → o/w.
- Lipophilic emulsifiers → w/o.

3. Plastic/interfacial film theory

- Emulsifier forms a thin film around droplets.
- Film toughness and flexibility determine stability.

Preparation of Emulsions

Factors affecting stability:

- Choice of emulsifier (compatibility, stability, safety, effectiveness).
- pH.
- Internal/external phase ratio.

Types of emulsifying agents

- Carbohydrates: acacia, tragacanth, agar → o/w.
- Proteins: gelatin, egg yolk, casein → o/w.
- High molecular weight alcohols: cetyl, stearyl alcohol → stabilizers.
- Wetting agents: anionic (SLS), cationic (benzalkonium chloride), nonionic (Span, Tween).
- Finely divided solids: bentonite, $Mg(OH)_2$, $Al(OH)_3$.

HLB system

- HLB 3–6 = w/o emulsifiers.
- HLB 8–18 = o/w emulsifiers.
- Each oil has a required HLB.
- Blends of surfactants can be calculated to match required HLB.

HLB Calculations (Examples)

- Example with Tween 80 (HLB 15) + Span 80 (HLB 4.3) to reach required HLB 10.5.
 - Algebraic calculation of fractions shown.
 - Another example with sorbitan monooleate + polyoxyethylene sorbitan monooleate.
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Preparation Methods

Small-scale laboratory methods

1. Continental (dry gum) → 4:2:1 ratio (oil:water:gum).
2. English (wet gum) → mucilage of gum with water, then add oil slowly.
3. Forbes bottle → shake oil + gum in bottle, then add water.

Auxiliary methods

- Hand homogenizer → reduces droplet size to $\sim 5 \mu\text{m}$.

In situ soap method

- Calcium soaps (w/o) formed by mixing oils + limewater (e.g., calcium oleate).

Large-scale

- Colloid mills, industrial homogenizers (up to 100,000 L/hr)

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