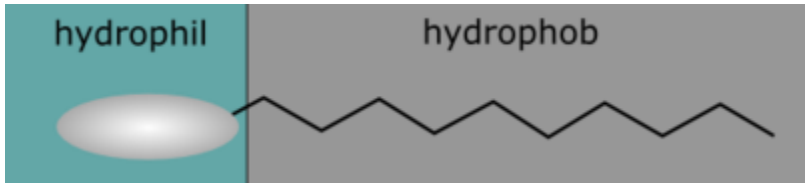
The HLB System

The hydrophilic-lipophilic balance (HLB) of the molecule determines the type of activity which may be expected of the agent. The compound will serve as a wetting agent, a detergent, a solubilising agent, an o/w or w/o emulsifying agent depending on the HLB.

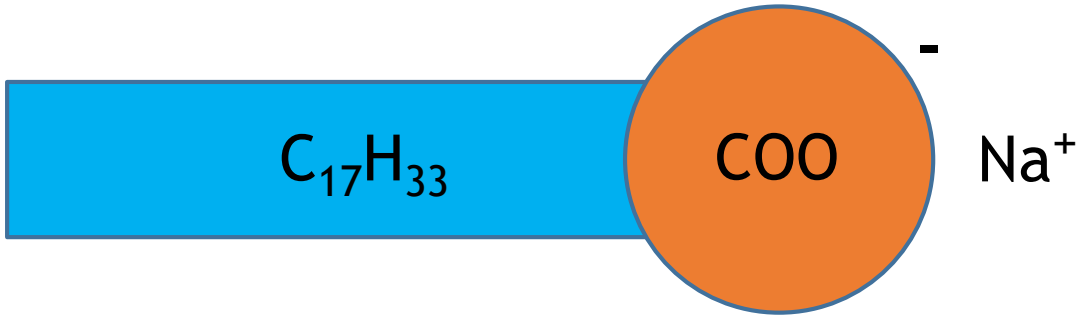
Each EA contains a water-attracting (hydrophilic part) and an oil-attracting (lipophilic part).



If the agent is too hydrophilic it dissolves completely in the aqueous phase and exerts no effect at the interface. If it is too lipophilic it dissolves completely in the oil phase and does not concentrate at the interface.

The molecule of a well-balanced emulsifying agent when dispersed initially in the oil or the aqueous phase, it will migrate to and concentrate predominantly at the interface, where it is oriented with the hydrophilic portion in the water and the lipophilic portion in the oil. An EA which displays these properties is said to have the proper HLB.

If an EA is hydrophilic it will tend to form an o/w emulsion, if it is lipophilic it will favour the formation of a w/o emulsion. Sodium oleate has a good o/w EA characteristics since it possesses a hydrophilic carboxyl group (COO^-) that predominates over the lipophilic hydrocarbon group ($C_{17}H_{33}$).



On the other hand, calcium oleate and other polyvalent soaps are predominantly lipophilic and form w/o emulsions.

The hydrophilic-lipophilic balance of surface active agents has been expressed in terms of a numerical scale that extends from 1-50 but the usual range is between 1-20.

An agent with a low HLB is lipophilic, while a surfactant a surfactant having a higher HLB is hydrophilic. For the preparation of a w/o emulsion, the EA should have an HLB value of about (3-6). An o/w emulsion on the other hand is favoured by an EA with HLB value of about (8-18).

ACTIVITY AND HLB VALUE OF SURFACTANTS

ACTIVITY	ASSIGNED HLB
Antifoaming	1–3
Emulsifiers (w/o)	3–6
Wetting agents	7–9
Emulsifiers (o/w)	8–18
Solubilizers	15–20
Detergents	13–16

In practice, Spans and Tweens are usually mixed to provide an emulsifier combination that has the HLB necessary to produce a stable emulsion of the desired type.

By knowing the required HLB of the oil phase, one may calculate the quantities of any Span and Tween that are necessary to produce the proper balance for a stable emulsion.

Each oil requires an EA of a specific HLB value for the formation of an o/w emulsion and another value for the formation of a w/o product. These are known as the “required HLB” values of the oil.

In the HLB system, in addition to assigning values to the EAs values are also assigned to oils. In using the HLB concept in the preparation of an emulsion, one selects EAs having the same or nearly the same HLB value as the oil phase of the intended emulsion.

For example, mineral oil has an HLB value of 4 if a w/o emulsion is desired and a value of 10.5 if an o/w emulsion is to be prepared. Therefore, to prepare a stable emulsion the EA should have an HLB value similar to the one of mineral oil depending on the type of emulsion required. When needed two or more EAs may be combined to achieve the proper HLB value.

Mixed EAs or a blend of emulsifiers is more efficient to give a stable emulsion than either each agent alone. The mixture contributes one or several actions:

1. It provides the proper hydrophilic-lipophilic nature.
2. It establishes a stable film at the interface.
3. It supplies the desired consistency to the product.

Mixed EAs tend to form interfacial complexes at the surface of the globules, for example the o/w emulsifying action of sodium oleate is improved by combination with cetyl alcohol or cholesterol through the tendency of the molecules to form a complex.

Tragacanth or agar are frequently combined with acacia to thicken the external phase of an o/w emulsion and reduce the rate of creaming. Pectin, alginates and cellulose esters are used as well for this purpose.

HLB VALUES FOR SELECTED EMULSIFIERS

AGENT	HLB
Ethylene glycol distearate	1.5
Sorbitan tristearate (Span 65[a])	2.1
Propylene glycol monostearate	3.4
Triton X-15[b]	3.6
Sorbitan monooleate (Span 80[a])	4.3
Sorbitan monostearate (Span 60[a])	4.7
Diethylene glycol monolaurate	6.1
Sorbitan monopalmitate (Span 40[a])	6.7
Sucrose dioleate	7.1
Acacia	8.0
Amercol L-101[c]	8.0
Polyoxyethylene lauryl ether (Brij 30[a])	9.7
Gelatin	9.8
Triton X-45[b]	10.4
Methylcellulose	10.5
Polyoxyethylene monostearate (Myrj 45[a])	11.1
Triethanolamine oleate	12.0
Tragacanth	13.2
Triton X-100[b]	13.5
Polyoxyethylene sorbitan monostearate (Tween 60[a])	14.9
Polyoxyethylene sorbitan monooleate (Tween 80[a])	15.0
Polyoxyethylene sorbitan monolaurate (Tween 20[a])	16.7
Pluronic F 68[d]	17.0
Sodium oleate	18.0
Potassium oleate	20.0
Sodium lauryl sulfate	40.0

Rx

Mineral oil		8 g
E.A. (Span 80 + Tween 80)		2 g
Purified water	q.s.	100 mL

The required HLB for the mineral oil = 10.5, the HLB for Span 80 = 4.3 and the HLB for Tween 80 = 15.

How much Span 80 and Tween 80 are required to produce a stable emulsion?

$$F_S * HLB\ s + F_T * HLB_T = \text{Required HLB of the oil}$$

Let the fraction of Span = X

Let the fraction of Tween = 1-X

X*4.3 + (1-X)*15 = 10.5

10.7 X = 4.5

X= 0.42 fraction of Span

Amount of Span = 2 * 0.42 = 0.84 g

1-X = 1- 0.42 = 0.58 fraction of Tween

Amount of Tween = 2 * 0.58 = 1.16 g

Let the fraction of Tween = X

Let the fraction of Span = 1-X

(1-X)*4.3 + X*15 = 10.5

10.7 X = 6.2

X= 0.58 fraction of Tween

Amount of Tween = 2 * 0.58 = 1.16 g

1-X = 1- 0.58 = 0.42 fraction of Span

Amount of Span = 2 * 0.42 = 0.84 g

Types of Emulsifying Agents

1. **Carbohydrate materials**, such as acacia, tragacanth, agar and pectin. These materials form hydrophilic colloids when added to water and generally produce o/w emulsions.
2. **Protein substances**, such as gelatine, egg yolk. These substances produce o/w emulsion.
3. **High molecular weight alcohols**, such as stearyl alcohol, cetyl alcohol and glyceryl monostearate. These substances are employed primarily as thickening agents and stabilisers for o/w emulsions used externally. Cholesterol and cholesterol derivatives may also employed in externally used emulsions to promote w/o emulsions.
4. **Wetting agents**, which may be anionic, cationic or non-ionic. The non-ionic surfactants are effective over pH range (3-10), cationic surfactants are effective over pH range (3-7) and anionic surfactants require a pH greater than 8.

5. **Finely divided solids**, such as colloidal clays including bentonite, magnesium hydroxide and aluminium hydroxide. These substances can form either o/w or w/o emulsions depending on the order of mixing.

Examples of oral emulsions

1. Castor oil Emulsion (o/w): This emulsion is utilised as a laxative. Castor oil works directly on the small intestine to promote bowel movement.
2. Simethicone Emulsion (o/w): used as a defoaming agent for the relief of painful symptoms of excess gas in the GIT. Available in drop form for infants.

- Sterile vitamin K Emulsion (o/w) for I.V. administration.