Physical Pharmacy

HLB (hydrophilic lipophilic balance)

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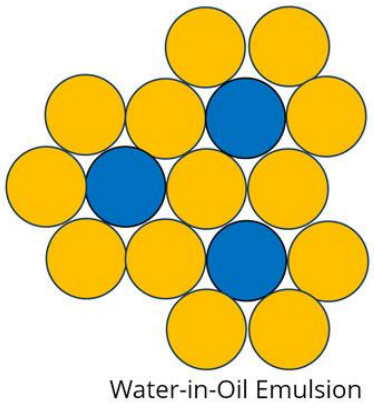
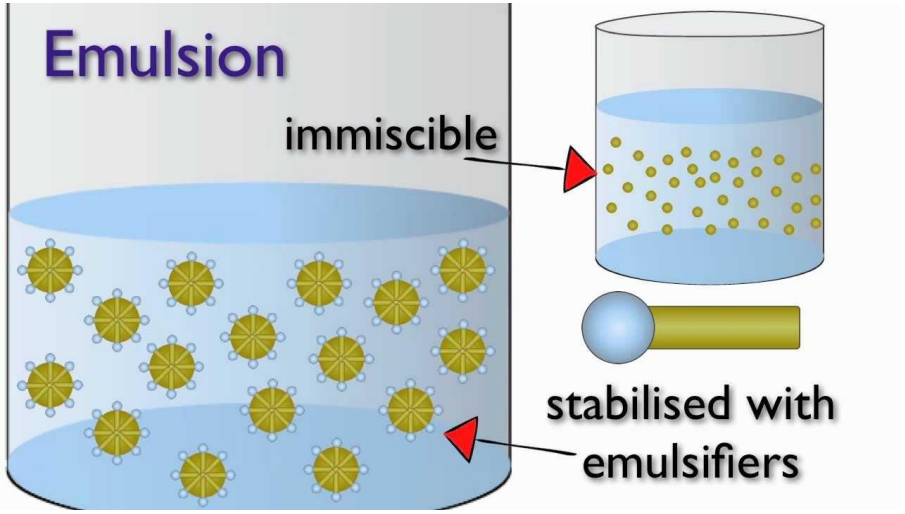
Emulsions

- An emulsion is a mixture of two or more liquids that are normally immiscible.
- In an emulsion, one liquid (the dispersed phase) is dispersed in the other (the continuous phase)
- Emulsions are stabilized by using surface active agents that let the two liquids incorporate in to each other.
- SAAs reduce the interfacial tension between the two liquids and let the dispersed phase to disperse through the continuous phase with out being solubilized.


Oil-in-Water Emulsion


Water-in-Oil Emulsion



Hydrophilic lipophilic balance HLB

- Surfactants can be more hydrophilic or lipophilic according to the type and size of the polar heads and non-polar tails.

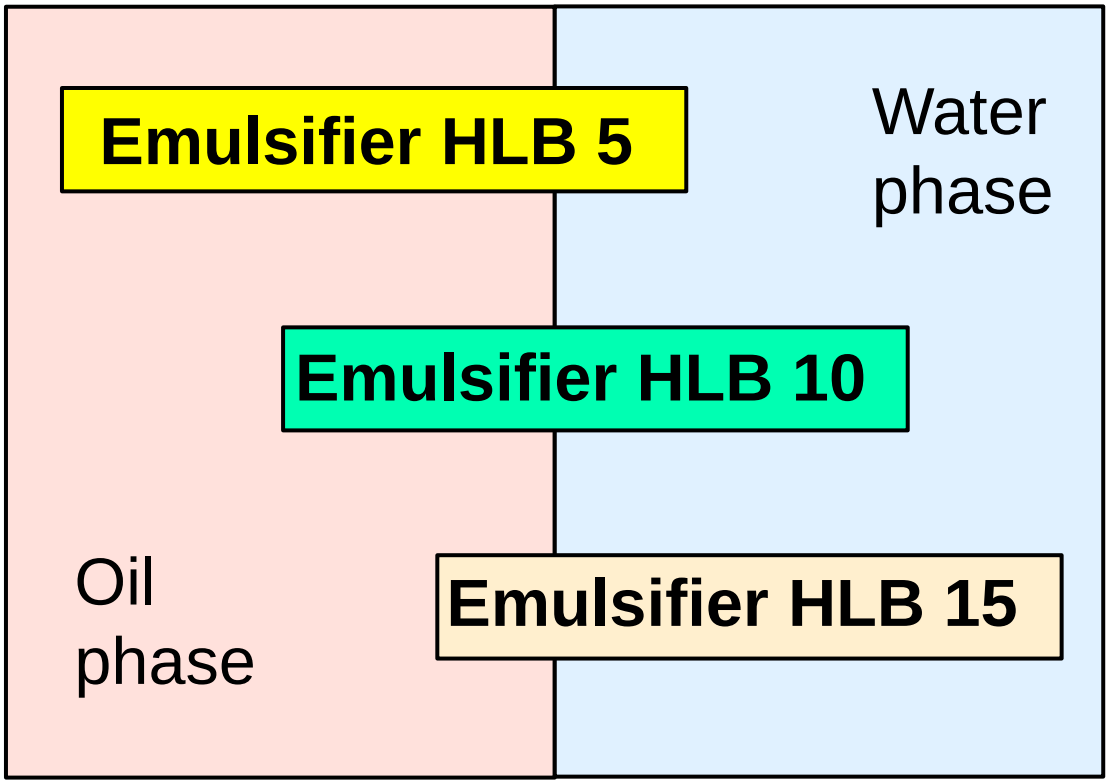
- The relationship (or balance) between the hydrophilic portion of the surfactant to the lipophilic portion is what we call HLB

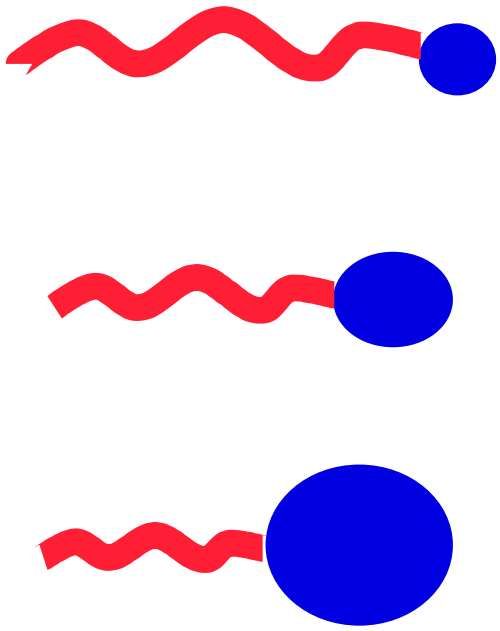
- The lower the HLB value the more lipophilic or oil soluble the surfactant is

- The higher the HLB value the more water soluble or hydrophilic the surfactant is.

- Each surfactant has its own HLB value.

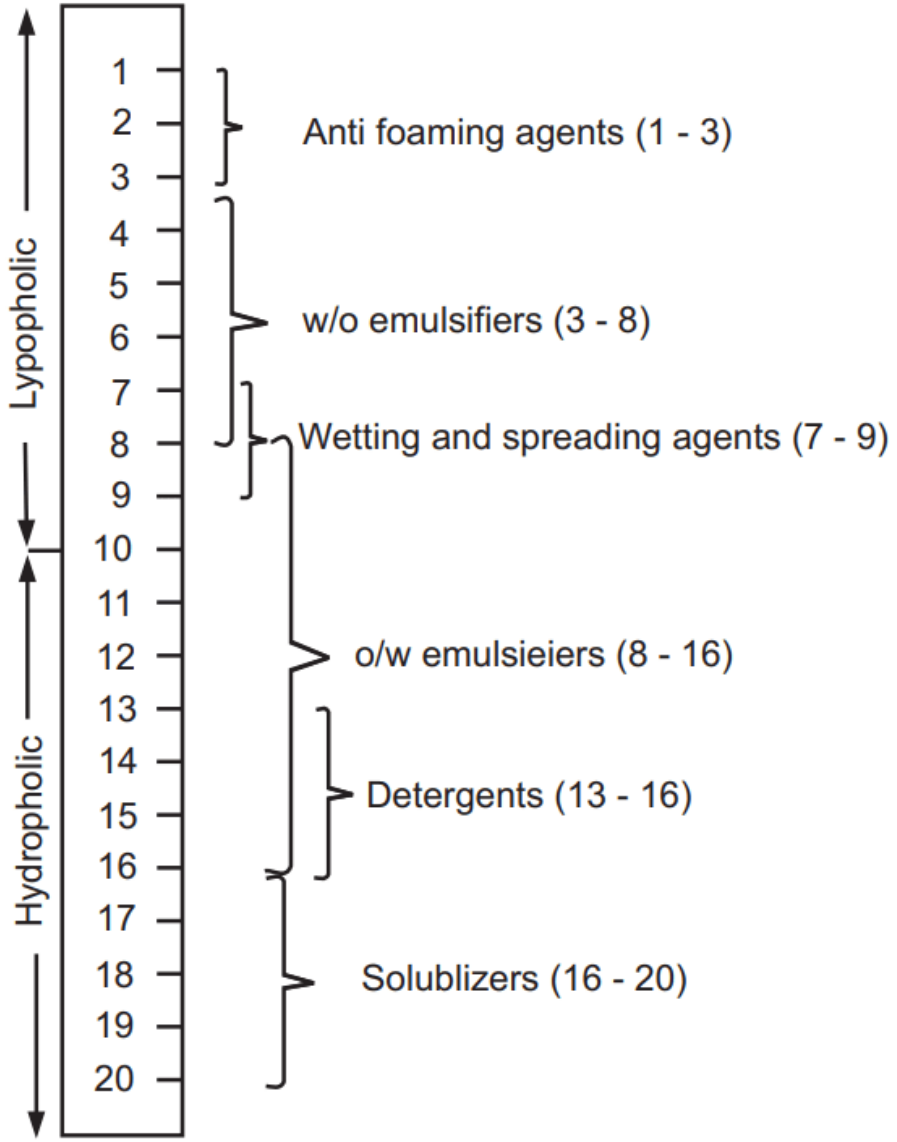
Hydrophilic lipophilic balance HLB Cont.





Required HLB (RHLB)

- Each surfactant is useful for a certain application
- Hydrophilicity and hydrophobicity (or its HLB) of a surfactant specifies which application it is used for.
- An emulsion is best stabilized with a surfactant with a certain HLB.
- If the HLB of the surfactant used is more or less than that certain HLB, the stability of the emulsion decrease and phase separation may occur earlier than expected.



Required HLB (RHLB) Cont.

- RHLB: The HLB value of the surfactant that provides the lowest interfacial tension between the aqueous and oil phase of an emulsion.
- Each oil has its own RHLB to be emulsified with water.
- If there are several oil ingredients the required HLB is calculated as a sum of their respective required HLB multiplied by the fraction of each.
- Each oil will have 2 required HLB's: one for its oil-in-water emulsions, the other for its water-in-oil emulsions

- Calculate the required HLB for this oil phase with water (from a prescription):

- Cetyl alcohol 15 g
- White wax 1g
- Lanolin 2 g

	Required HLB (from reference)		Fraction	
• Cetyl alcohol	15	x	15/18	12.5
• White wax	12	x	1/18	0.7
• Lanolin	10	x	2/18	1.1
• **Total required HLB**				**14.3**

Required HLB (RHLB) Cont.

Another Example

- **A simple O/W lotion formula:**
  - mineral oil 8 %
  - caprylic/capric triglyceride 2 %
  - isopropyl isostearate 2 %
  - cetyl alcohol 4 %
  - emulsifiers 4 %
  - polyols 5 %
  - water soluble active 1 %
  - water 74 %

Required HLB (RHLB) Cont.

Another Example Cont.

- **Add up the oil phase ingredients:**
  - **mineral oil** **8 %**
  - **caprylic/capric triglyceride** **2 %**
  - **isopropyl isostearate** **2 %**
  - **cetyl alcohol** **4 %**

  - emulsifiers 4 %
  - polyols 5 %
  - water soluble active 1 %
  - water 74 %

Required HLB (RHLB) Cont.

Another Example Cont.

- **Divide each by the total to get the contribution to the oil phase:**
  - **Mineral oil** **8 / 16 = 50%**
  - **caprylic/cap. trig.** **2 / 16 = 12.5%**
  - **isopropyl isostearate** **2 / 16 = 12.5%**
  - **cetyl alcohol** **4 / 16 = 25%**

Required HLB (RHLB) Cont.

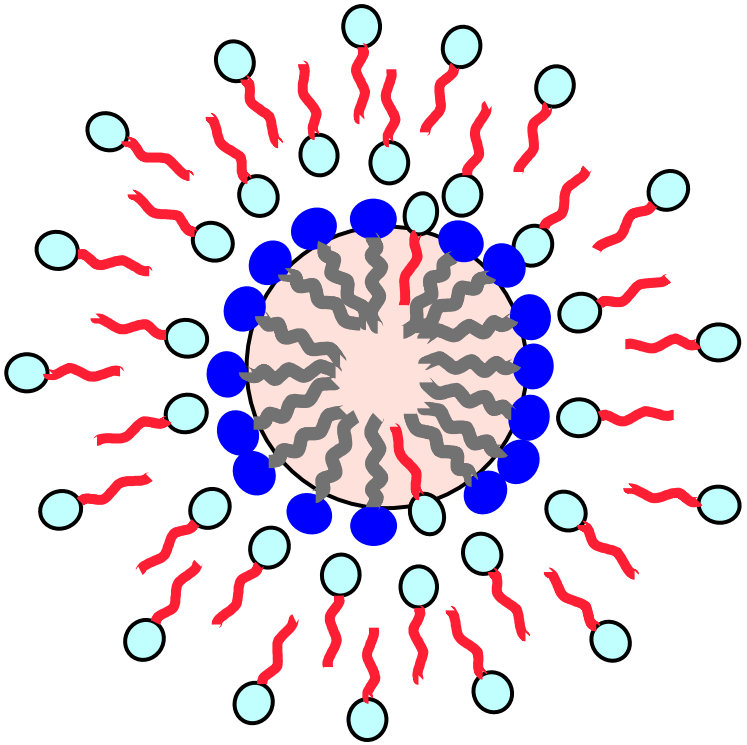
Another Example Cont.

- **Calculations for HLB of this unique blend:**

Oil phase ingredient	contribution	X Required HLB of ingredient	equals
Mineral oil	50.0%	10.5	5.250
Caprylic cap. Trig.	12.5%	5	0.625
Isopropyl isostearate	12.5%	11.5	1.437
Cetyl alcohol	25.0%	15.5	3.875
		Total	**11.2**

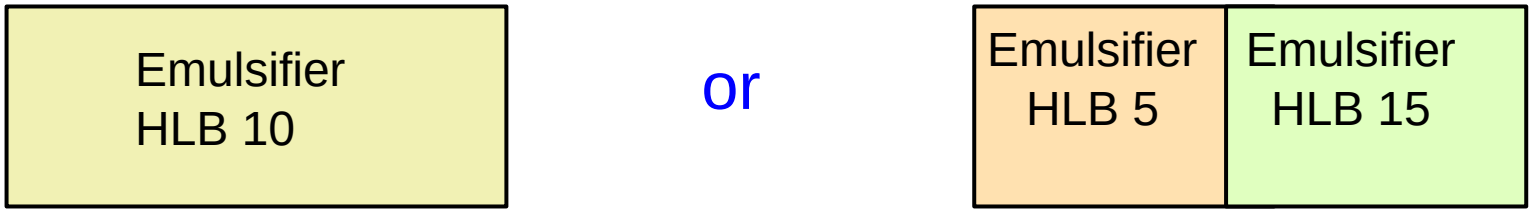
Surfactant blends

- When preparing an emulsion it is recommended to use a blend of at least two surfactants instead of only one.
- Reason:
  - experience has shown the benefit
  - mixtures of a low HLB and a high HLB surfactant give better coverage at the interface



Calculations involving HLB

- In the HLB system the HLB of the emulsifier blend is additive for example if an oil system had a required HLB of 10 you could use either:



- This equation is used to know at which ratio each of two surfactants to use:

$$\textbf{\% higher HLB SAA} = \frac{\text{RHLB} - \text{HLB low}}{\text{HLB high} - \text{HLB low}}$$

- For the above example the (% higher HLB SAA) result is 50% or 0.5, to confirm:
  - 0.5 X 5 = 2.5
  - 0.5 X 15 = 7.5
  - **2.5 + 7.5 = 10**

Calculations involving HLB Cont.

- Now that we can find out the **ratio (not amount)** of each of lower and higher HLB surfactants to use, lets know how much (quantity) of the surfactant mixture to use.
- This equation is used:

$$Q_s = \frac{6(\rho_s/\rho)}{10 - 0.5 \cdot \text{RHLB}} + \frac{4Q}{1000}$$

where ρ_s is the density of the surfactant mixture, ρ is the density of the dispersed (internal) phase, and Q is the percentage of the dispersant (continuous phase) of the emulsion. The required HLB, written as RHLB, is the HLB of the oil phase needed to form an O/W or W/O emulsion.

W/O and O/W Formulations

We wish to formulate two products, (*a*) a W/O and (*b*) an O/W emulsion, containing 40 g of a mixed oil phase and 60 g of water.

(*a*) The oil phase consists of 70% paraffin and 30% beeswax. The density of the oil phase is 0.85 g/cm^3 and the density of the aqueous phase is about 1 g/cm^3 at room temperature. The density of the mixture of surfactants for the W/O emulsion is 0.87 g/cm^3. The required HLB values of paraffin and of beeswax for a W/O emulsion are 4.0 and 5.0, respectively.

The amount Q_s in grams of a mixture of sorbitan tristearate (HLB = 2.1) and diethylene glycol monostearate (HLB = 4.7) to obtain a *water-in-oil emulsion* is obtained

Questions?