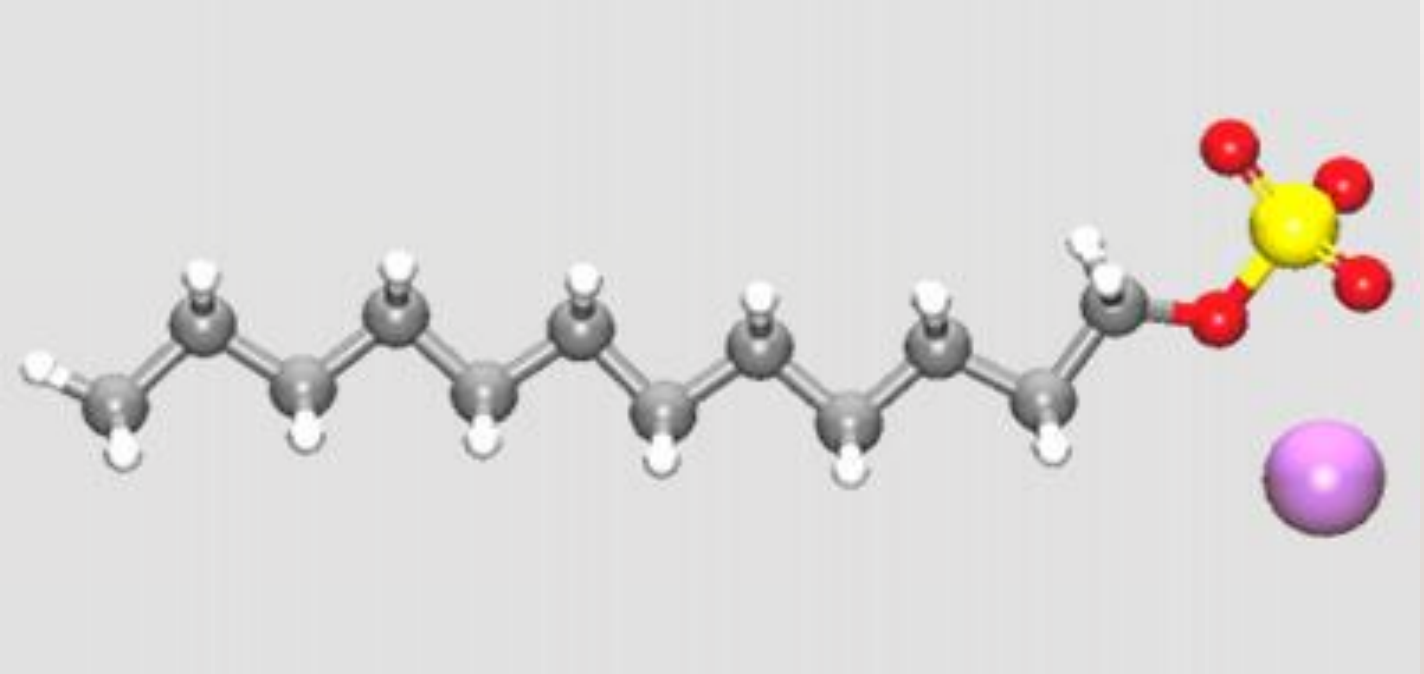
Hydrophilic-Lipophilic Balance (HLB)

For CH462 Module

Definition

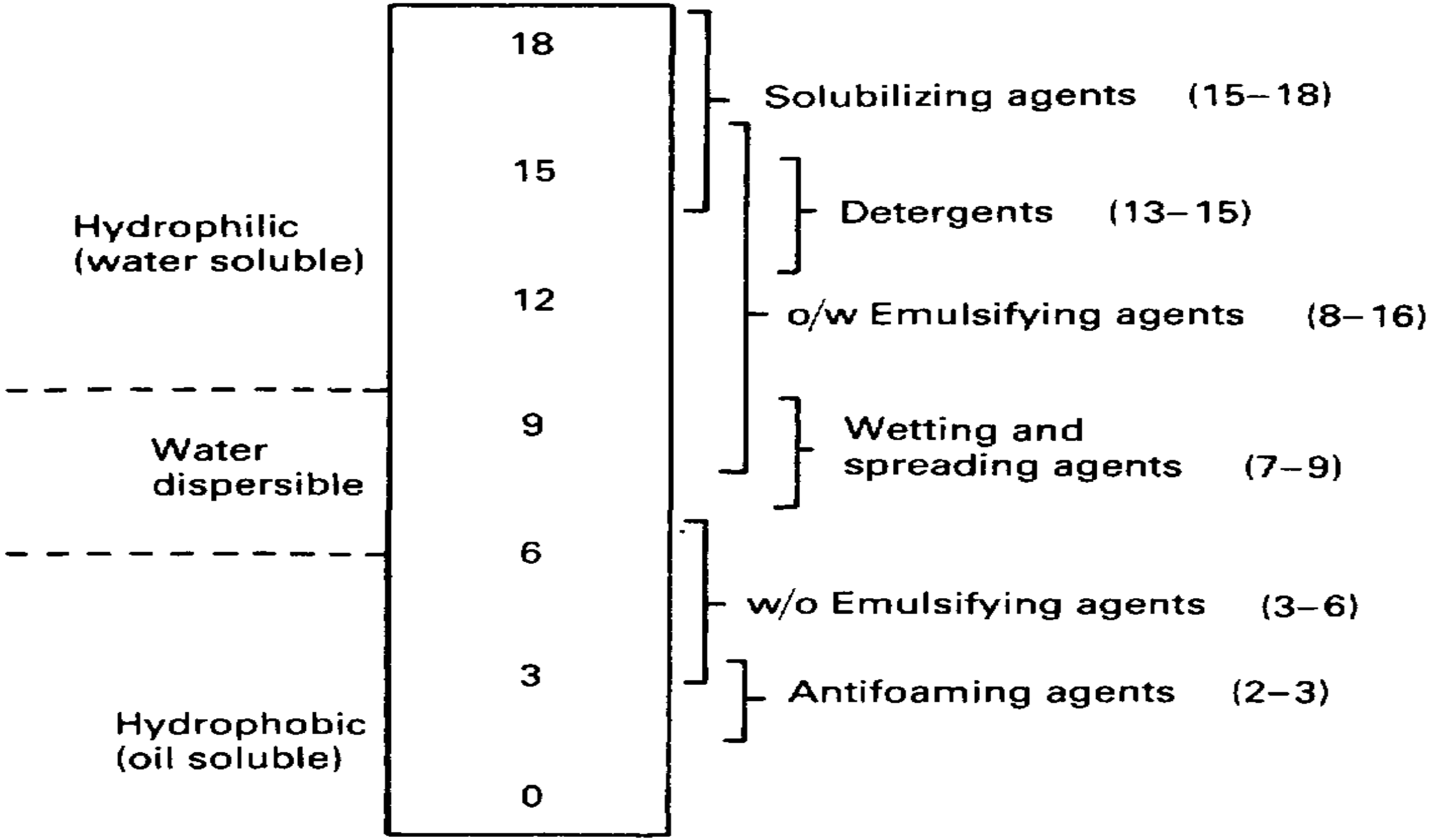
It is the relative efficiency of the hydrophilic portion of the surfactant molecule to its lipophilic portion of the same molecule.



HLB Griffin´s Scale

- It is an arbitrary scale between 0 and 20 which expresses ***numerically*** the **size** and **strength** of the **polar** portion relative to the **non-polar** portion of the molecule.

- Although originally applied to **non-ionic** surfactants, its use has now been extended to **ionic** surfactants (HLB for ionic surfactants are much **higher**, up to 50, based on the ionization properties.


18
15
12
9
6
3
0
Hydrophilic
(water soluble)
Water
dispersible
Hydrophobic
(oil soluble)
Solubilizing agents (15–18)
Detergents (13–15)
o/w Emulsifying agents (8–16)
Wetting and
spreading agents (7–9)
w/o Emulsifying agents (3–6)
Antifoaming agents (2–3)

Aim of HLB Griffin´s Scale

- Although the HLB approach is empirical, it does allow comparison between different chemical types of surfactants.
- Besides that, it provides a systematic method of selecting mixtures of emulsifying agents to produce physically stable emulsions.
- The higher surfactant HLB value, the more hydrophilic it is.
- The lower surfactant HLB value, the more lipophilic it is.

Examples of Surface active agents on Griffin´s scale

- ***Spans*** are sorbitan fatty acid esters having *low* HLB values ranging from 1.8 to 8.6.
- ***Tweens*** are polyoxyethylene derivatives of spans. So, they are more hydrophilic having *higher* HLB values ranging from 9.6 to 16.7.

Determination of the Required HLB values and Blending of Surfactants

- Oils used in the formulation of emulsions require a certain HLB value to be formulated as w/o emulsion or o/w emulsion.

- For the same oil, the required HLB value for O/W emulsion is ***higher*** than the required HLB value for W/O emulsion.

Oil	O/W emulsion	W/O emulsion
Stearic acid	15	6
Cetyl alcohol	15	----------
Stearyl alcohol	14	----------
Lanolin, anhydrous	12	8
Mineral oil, light	12	4
Liquid paraffin	10.5	4
Castor oil	14	----------
Beeswax	9	5
Petrolatum	7-8	4
Wool fat	10	8

Calculation of the required HLB for a mixture of oils, fats or waxes

1. Multiply the required HLB of each ingredient by its fraction from the total oily phase.
2. Add the obtained values to get the total required HLB for the whole oily phase.

Example:

Liquid paraffin	35%
Wool fat	1 %
Cetyl alcohol	1%
Emulsifier system	7%
Water to	100%

Solution

The total percentage of the oily phase is 37 and the proportion of each is:

Liquid paraffin 35/37 x 100 = 94.6%

Wool fat 1/37 x 100 = 2.7%

Cetyl alcohol 1/37 x 100 = 2.7%

The total required HLB number is obtained as follows:

Liquid paraffin (HLB 10.5)	94.6/100 X 10.5	= 9.93
Wool fat (HLB 10)	2.7/100 x 10	= 0.3
Cetyl alcohol (HLB 15)	2.7/100 X 15	= 0.4
Total required HLB		= 10.63

Calculation of ratio of emulsifier to produce a particular required HLB value

- One of the most important aspects of the HLB system is that HLB values are ***additive*** if the ***amount*** of each in a blend is taken into account. Thus, ***blends*** of high and low HLB surfactants can be used to obtain the ***required HLB of an oil***.
- The HLB of the mixture of surfactants, consisting of fraction x of A and (1-x) of B is assumed to be the algebraic mean of the two HLB numbers, i.e.:

$$HLB_{mixture} = x\ HLB_A + (1-x)\ HLB_B$$

- Rearrangement the above equation in percent (%) form will be

$$A = 100\ (X-HLB_B) / (HLB_A - HLB_B)$$

$$B = 100 - A$$

Where X is the required HLB of the surfactant (oil) mixture

Worked example

A formulator is required to formulate an o/w emulsion of the basic formula:

Liquid paraffin	50 g
Emulsifying agents (required HLB 10.5)	5 g
Water	to 100 g

Calculate the fraction of Tween 80 (HLB of 15) and Span 80 (HLB of 4.3) used to produce a ***physically stable liquid paraffin emulsion***.

Solution

Assume that Tween 80 is A and Span 80 is B. So,

$$\mathbf{A = 100\ (x\text{-}HLB_B) / (HLB_A\text{-}HLB_B)}$$

$$= 100\ (10.5\text{-}4.3) / (15\text{-}4.3)$$

$$= 57.9\%$$

$$\mathbf{B = 100 - A}$$

$$= 100\text{-}\ 57.9 = 42.1\ \%$$

$$A = \frac{57.9 \times 5}{100} = 2.89\ g$$

$$B = 5 - 2.89 = 2.11\ g$$

Problem 1

What is the HLB value of a mixture consisting of 40% span60 (HLB 4.7) and 60% Tween 60 (HLB 14.9).

Solution

Assuming

A: tween 60 , B: span 60

$$A = 100 (X - HLB_B) / (HLB_A - HLB_B)$$

$$60 = 100 (x - 4.7) / (14.9 - 4.7)$$

$$60 = 100x - 470 / 10.2$$

$$X = 10.82$$

Problem 2

What is the HLB value of a surfactant blend consisting of 20% tween20 (HLB 16.7), 30% span20 (HLB 8.6) and 50% span80 (HLB 4.3).

Solution A:

Assuming

A: tween 20 , B: span 20 and C: span80

Solution A:

$$HLB_{mixture} = \text{fraction of A } HLB_A + \text{fraction of B } HLB_B + \text{fraction of C } HLB_c$$

$$= (0.2 \times 16.7) + (0.3 \times 8.6) + (0.5 \times 4.3) = 8.07$$

Solution B:

$$A = 100\,(x\text{-}HLB_B) / (HLB_A - HLB_B)$$

$$40 = 100\,(x - 8.6) / (16.7 - 8.6)$$

$$x = 11.84$$

Then we consider that A is the blend of A (tween 20) and B (span 20) and B is span 80. So,

$$A = 100\,(x\text{-}HLB_B) / (HLB_A - HLB_B)$$

$$50 = 100\,(X - 4.3) / (11.84 - 4.3)$$

$$X = 8.07$$

Problem 3

What is the HLB value of an emulsifier blend consisting of 25% span20 (HLB 8.6) and 75% tween20 (HLB 16.7).

Solution

Assuming

A: tween 20 , B: span 20

$$A = 100 (X - HLB_B) / (HLB_A - HLB_B)$$

$$75 = 100 (x - 8.6) / (16.7 - 8.6)$$

$$75 = 100x - 860 / 8.1$$

$$X = 14.67$$

Problem 4

Calculate the HLB value of a mixture consisting of 45 g of span80 (HLB 4.3) and 55 g of polysorbate (tween 80) (HLB 15).

Solution

Assuming

A: tween 80 , B: span 80

$$A = 100 (X - HLB_B) / (HLB_A - HLB_B)$$

$$55 = 100 (x - 4.3) / (15 - 4.3)$$

$$55 = 100x - 430 / 10.7$$

$$X = 10.18$$

Problem 5

A mixture of two surface active agents having an HLB value of 13.5, calculate the percent of each if it consists of Brij35 (HLB 16.9) and span80 (HLB 4.3).

Solution

Assuming

A: Brij35 , B: span 80

$$A = 100\ (X - HLB_B) / (HLB_A - HLB_B)$$

$$A = 100\ (13.5 - 4.3) / (16.9 - 4.3)$$

$$A = 920 / 12.6$$

$$A = 73.01\ \%$$

$$B = 100 - A$$

$$B = 100 - 73.01$$

$$B = 26.98\ \%$$

Problem 6

Calculate the required HLB value for the oil phase of the following O/W emulsion:

Rx

Cetyl alcohol	15 g
White wax	1 g
Lanolin anhydrous	2 g
Emulsifier	q.s
Glycerin	5 g
Distilled water to	100 g

RHLB of cetyl alcohol = 15

RHLB of white wax = 12

RHLB of lanolin anhydrous = 10

Solution

The total amount of oily phase is 18 g and the proportion of each is:

Cetyl alcohol	15/18 x 100 = 83.34%
White wax	1/18 x 100 = 5.56%
Lanolin anhydrous	2/18 x 100 = 11.12%

Then the total required HLB is obtained as follows:

Cetyl alcohol	83.34/100 x 15 = 12.5
White wax	5.56/ 100 x 12 = 0.66
Lanolin anhydrous	11.12 /100 x 10 = 1.11
Total required HLB	14.27

Problem 7

RX

Stearyl alcohol	8%
Cetyl alcohol	1%
Lanolin anhydrous	1%
Emulsifier	4%
preserved water ad.	100%

a)Calculate the RHLB of the oil phase where RHLB sterayl alcohol 15, RHLB for cetyl alcohol is 15, and RHLB for lanolin anhydrous is 10.

b) How many grams of span 80(HLB 4.3) and how many grams of tween 60 (HLB 14.9) should be used in formulating 1000 gms of this product.

Solution

a. The total percentage of the oily phase is 10%. So, the proportion of each is:

Stearyl alcohol	8/10 x 100 = 80%
Cetyl alcohol	1/10 x 100 = 10%
Lanolin anhydrous	1/10 x 100 = 10%

The required HLB for the oily phase will be:

Stearyl alcohol	80/100 x 15 = 12
Cetyl alcohol	10/100 x 15 = 1.5
Lanolin anhydrous	10/100 x 10 = 1
Total RHLB	14.5

b. Assume

A: Tween 60 and B: Span 80

$A = 100\ (x\text{-}HLB_B) / (HLB_A\text{-}HLB_B)$

$A = 100\ (14.5 - 4.3) / (14.9 - 4.3)$

A = 96.22% So, B = 100 – A = 3.78%

Because of the total amount of emulsifier in formula: 4%

So, A = 96.22 / 100 x 4 = 3.85% → 3.85 g and B = 3.78 / 100 x 4 = 0.15% → 0.15 g

*** Note that he asked about amount for 1000 gms of the product but the given formula for only 100 gms. So, the required amounts in grams must be multiplied by Factor (1000/100).**

For 1000 grams:

A = 3.85 x 10 = 38.5 g B = 0.15 x 10 = 1.5 g


Thank You!