11.2. HLB Value and Calculation

HLB; According to Griffin, the amphiphilic molecule is the value obtained by dividing the weight percentage of the hydrophilic part by five. There is a balance between hydrophilic and lipophilic parts of amphiphilic molecules. This is expressed as the hydrophilic-lipophilic balance (HLB).

Griffin has established an empirical scale as a measure of the HLB values of surfactants. With this , it is possible to determine the optimum range for each of surface active substance effect. The surfactant with a lower HLB has a lipophilic character. Spans, which are sorbitan esters, have lipophilic properties and low HLB values (1.8-8.6). Tweens, which are polyoxyethylene derivatives of spans, are hydrophilic and have high HLB values (9.6-16.7). In order to form stable emulsions, an emulsifier or emulsifier mixture having HLB value equal to the HLB value of the oil phase should be used.

Different formulas can be used to calculate the HLB values of surface active substances:

- The HLB value of a nonionic surfactant, has polyoxyethylene as a hydrophilic part

$$HLB = E / 5$$

can be calculated with this equation.

E: Percentage by weight of ethyleneoxide

- HLB value of fatty acid esters of polyhydric alcohols such as glyceryl monostearate,

$$HLB = 20 [1-(S / A)]$$

is calculated with that equation.

S: Number of ester saponification
A: Acid number of the fatty acid

The HLB values of some of the most frequently used surfactants are shown in Table 11.1.

A specific HLB called; necessary hydrophile-lipophilic balance (RHLB) & quot; is required for the oil phase of an oil in water (o/w) type emulsion. A different RHLB is required to form an oil-in-water (w/o) type emulsion with the same oil phase. HLB values for both emulsions of type o/w and w/o can be empirically determined for many oils and fats.

Example:
Oil/water type emulsion formulation and RHLB values

		RHLB
Wax	15 g	9
Lanolin	10 g	12
Solid paraffin	20 g	10
Cetyl alcohol	5 g	15
Emulsifier	2 g	
Preservative	0.2 g	
Paint	q.s.	
Purified water q.s	100 g	

The total RHLB value is the sum of the values obtained by multiplying the weight fraction and the RHLB value of each oil-like component contributing to the oil phase.

Beeswax   (15/50) x 9 =   2.70
Lanolin   (10/50) x 12 =   2.40
Paraffin   (20/50) x 10 =   4.00
Cetyl alcohol (5/50) x 15 = 1.50

Total HLB (for emulsion)   10.60

Thereafter, two emulsifiers with HLB values one below and one above the HLB value for the emulsion (HLB = 10.6 in this example) are selected. As an example, we choose Tween 80 with an HLB value of 15 and Span 80 with an HLB value of 4.3.

        % Tween 80 = (RHLB- HLB low) / (HLB high – HLB low)

using the equation

        % Tween 80 = (10.6 - 4.3) / (15.0 – 4.3) = 0.59

calculated.

For the o / w type emulsion, 2.0 g emulsifier was required. For this reason, for a 100 g emulsion, 2.0 x 0.59 = 1.18 g Tween 80 should be taken and the remainder 0.82 g should be completed with Span 80.

Table 11.1. HLB values of some surfactants.

Surface Active Agents	HLB
Oleic acid	1.0
Polyoxyethylene sorbitol wax derivative (G-1706)	2.0
Sorbitan tristearate	
Glyceryl monostearate	2.1
Sorbitan mono-oleate (Span 80)	3.8
Diethylene glycol monostearate	4.3
Glyceryl monostearate (Tegin)	4.7
Diethylene glycol monolaurate	5.5
Sorbitan monolaurate (Span 20)	6.1
Polyethylene lauryl ether (Brij 30)	8.6
Jelatin (Pharmagel B)	9.5
Methyl cellulose (Methocel 15 cP)	9.8
Polyoxyethylene lauryl ether (G-3705)	10.5
Polyoxyethylene monostearate (Myrj 45)	10.8
Triethanolamine oleate	11.1
Polyoxyethylene alkyl phenol (Igepal Ca-630)	12.0
Polyethylene glycol 400 monolaurate	12.8
Polyoxyethylene sorbitan mono-oleate	13.1
(Tween 80)	15.0
Polyoxyethylene sorbitan monolaurate	
(Tween 20)	16.7
Polyoxyethylene lauryl ether (Brij 35)	
Sodium oleate	16.9
Potassium oleate	18.0
Sodium lauryl sulphate	20.0
	40.0

Practice 12.7.

Water in Oil Type Cream (W/O)		HLB value
Mineral oil	16 g	11
Stearic acid	2 g	15
Cetyl alcohol	4 g	15
Glyceryl monostearate	2 g	
Emulsifier	4 g	
Glycerine	9 g	
Purified water ym	100 g	

HLB value of Tween 80: 15
HLB value of Span 80 : 4.3

The water and oil phases are heated in separate vessels to 70-72°C on a water bath.
The water phase is added to the oil phase slowly and it is stirred continuously.
Continue stirring until the temperature reaches to room temperature.

Questions:
1. Describe what the HLB value is.
2. Calculate the HLB value of the emulsifier in the above prescription.
3. What type of emulsion you want to create with the HLB value you find in the second question? What is the ideal HLB value for O/W and W/O type emulsions?
4. What is the intended purpose of this cream formulation. Write also the intended purpose of the ingredients.

Practice 16.13.

	%
Liquid paraffin	2.40
Isopropyl myristate	2.40
Stearic acid	2.90
Lanolin	0.50
Cetyl alcohol	0.40
Glyceryl stearate	1.00
Triethanolamine	0.95
Propylene glycol	4.80
Cetyl pyridinium chloride	0.20
Color agent	q.s.
Perfume	q.s.
Preservative	q.s.
Purified water	84.45