E-ISSN: 2788-9270
P-ISSN: 2788-9262
NJPS 2021; 1(2): 23-24
Received: 07-05-2021
Accepted: 08-06-2021

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Determination of HLB value by saponification method: A brief review

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Abstract
HLB (Hydrophilic lipophilic balance) value is the balance of the size and strength of the hydrophilic and lipophilic moieties of a surfactant molecule. The different method are available to calculate the HLB value of different ingredients. Saponification is one of the method to calculate HLB value, this method is accurate and widely help to decide the surfactant in Pharma industry.

Keywords: HLB value, surfactant, saponification, acid value, HLB scale

1. Introduction
HLB is short for hydrophilic-lipophilic balance. The HLB System is one of the most successful strategies for developing stable emulsions. Griffin has established an empirical scale as a measure of the HLB values of surfactants. It is possible to determine the optimum range for each of surface active substance effect. The HLB system was created as a tool to make it easier to use non-ionic surfactants.

1.1 History of HLB
The HLB number scale, introduced by Griffin in 1949 was the first-ever successful attempt of a quantitative characterization of the polyoxyethylene non-ionic surfactants. It has often been found that the classification of surfactants by HLB number is not helpful in enabling researchers to predict the optimum emulsification. To resolve the misfit between the HLB number and the solution properties, and applications, the new method has been proposed by using the chromatography technique to introduce the novel index, integrated surfactant potency (ISP).
The alternative methods used to calculate the HLB number, such as Davies' method and the organic conceptual diagram, have been proposed subsequently, the HLB values obtained by these three methods are incompatible, leading to an undesired formulation.

Griffin's method for non-ionic surfactants as described in 1954 works as follows:

$$HLB = 20 * \frac{Mh}{M}$$

Where Mh is the molecular mass of the Hydrophilic portion of the molecule, and M is the molecular mass of the whole Molecule, giving a result on a scale of 0 to20. An HLB value of 0 corresponds to a completely lipophilic/hydrophobic. Molecule, and a value of 20 corresponds to a completely hydrophilic/lipophilic Molecule.
In 1957, Davies suggested a method based on calculating a value based on the chemical groups of the molecule. The advantage of this method is that it takes into account the effect of stronger and weaker hydrophilic groups.

1.2 HLB Scale
Hydrophilic–lipophilic balance (HLB) is the scale of the size and strength of the hydrophilic and lipophilic moieties of a surfactant molecule [1].

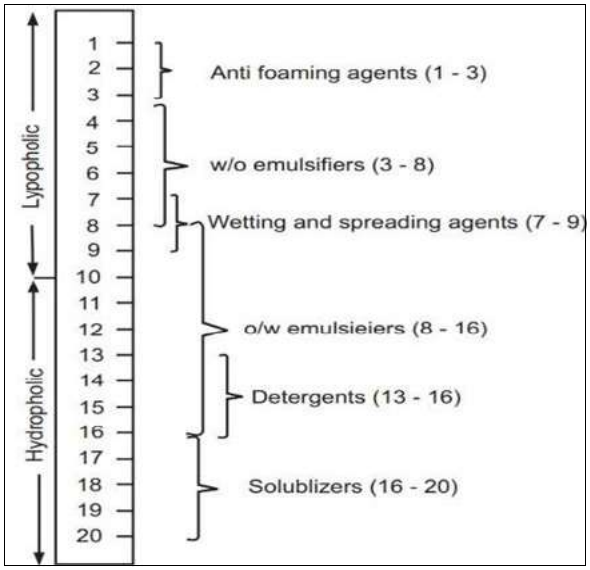

Fig 1: HLB Scale as described by Griffin

2. Determination of HLB value

Method 1:

In a non-ionic surfactant, where polyoxyethylene groups are present as a hydrophilic part, the HLB value can be calculated by using following formula,

HLB= E / 5

Where
E is percentage by weight of ethylene oxide.

Method 2:

HLB value of fatty acid esters of polyhydric alcohols such as glyceryl monostearate can be calculated by using following formula,

$$HLB = 20 * \left(1 - \frac{S}{A}\right)$$

Where S is number of ester saponification and A is acid number of the fatty acid [1].

2.1 Saponification method (Method 2)

Saponification is the hydrolysis of an ester with NoaH or KOH to give alcohol and sodium or potassium salt of the acid. Soaps are sodium or potassium salts of long chain fatty acids. When triglycerides in fat/oil react with aqueous NaOH or KOH, they are converted into soap and glycerol. This is called alkaline hydrolysis of esters. Since this reaction leads to the formation of soap, it is called the Saponification process.

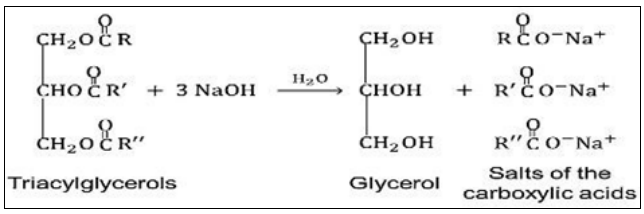

Fig 2: Hydrolysis of triglycerides into glycerol and fatty acid

Procedure for Saponification method

Around 1 gram of sample (Tween 20) is accurately weighed and Transferred to round bottom flask. 30 ml 0.5N alcoholic potassium hydroxide is added and refluxed on a boiling water bath for about 1 hour. A blank experiment is performed in the same way but without using the sample. The reaction mixtures are cooled down to room temperature and titrated against standard 0.5N hydrochloric acid using phenolphthalein as indicator and taking colour change from pink colour or colour less or slightly pale yellow as an end point [2].

Calculation as per method 2

$$\text{Saponification Number (S)} = \frac{(V2 - VI) \text{ x Normality of hydrochloric acid}}{\text{Amount of sample (gm)}}$$

$$HLB = 20 * \left(1 - \frac{S}{A}\right)$$

2.2 Application of HLB value

HLB value used in product development including Pharmaceutical, Food industry, chemical industry. Hydrophilic Lipophilic Balance (HLB) is a way of measuring a substances solubility within water or oil. It is important for surfactant selection. It used for the identification of emulsion. The HLB system was created as a tool to make it easy to use non-ionic surfactants.
HLB values of some surfactants and oils are given in table 1 for ready reference [1].

Table 1: HLB value of different oils and surfactants

Names of surfactants	HLB
Sorbitan laurate (Span 20)	8.6
Sorbitan palmitate (Span 40)	6.7
Sorbitan stearate (Span 60)	4.7
Sorbitan oleate (Span 80)	4.3
Sorbitan trioleate (Span 85)	1.8
Polyoxyethylene sorbitan laurate (Tween 20)	16.7
Polyoxyethylene sorbitan palmitate (Tween 40)	15.6
Polyoxyethylene sorbitan stearate (Tween 60)	14.9
Polyoxyethylene sorbitan oleate (Tween 80)	15.0
Polyoxyethylene sorbitan trioleate (Tween 85)	11.0
Brij 30	9.5
Brij 35	16.9
Sodium oleate	18.0
Potassium oleate	20..0

3. Reference

1. Patrick J. Sinko, Martin's Physical Pharmacy and Pharmaceutical Science, edition-5th 437.
2. Guru Prasad Mohanta, Prabal Kumar Manna, physical pharmacy practical text, Pharma Book Syndicate, Hyderabad 2006, 30.