Abstract

When one is faced with the task of making an emulsion, there are thousands of emulsifying agents to choose from. Out of this overwhelming number of products, the formulator has the unenviable task of selecting one or two that will satisfactorily emulsify the desired ingredients.

To help save time with emulsifier selection, a system was developed where emulsifiers are given a number that correlates to their “Hydrophilic-Lipophile Balance”. This HLB system, offers a strategic approach to determining which emulsifiers are best suited for use in one’s formulations.

The HLB system was created as a tool to make the selection of non-ionic emulsifiers easier. This allows the scientist to calculate the HLB value of a non-ionic emulsifier as well as determine the required HLB for various water insoluble ingredients used in emulsions. When these are properly matched, stable formulations can easily be obtained.

The use of the HLB system also helps the formulator better understand the structure/function relationship of emulsifiers.

Introduction

What is the HLB system?

All non-ionic emulsifiers (a.k.a. surfactants) contain one or more hydrophilic and lipophilic groups. These groups allow the product to associate itself with the water and oil phase respectively. The relationship (or balance) of hydrophilic to lipophilic content in a product is called its HLB value.

The HLB system was developed by William Griffin in the 1940’s and is used to assign HLB values to non-ionic surfactants from 0-20 with 0 being water insoluble and 20 being fully water soluble. The HLB of the surfactant is related to its solubility; a surfactant with a low HLB tends to be oil soluble and one with high HLB tends to be water soluble. The HLB value can be estimated by empirical rules from the analysis of the surfactant. (1)

Calculating HLB value of the surfactant

The HLB value for most of the nonionic surfactants is merely an indication of the percentage weight of the hydrophilic portion of the nonionic surfactant.

\[
\text{HLB} = \frac{\text{Molecular Weight of hydrophilic portion}}{\text{Molecular weight of entire Molecule}} \times 20
\]

In the case of the surfactants where the hydrophilic portion consists of ethylene oxide only, the HLB can be calculated as:

\[
\text{HLB} = \frac{E}{5}
\]

Where E = weight percent of oxyethylene content (2)

A slightly more complicated method is used for calculating the HLB of products based on polyol fatty acid esters such as Sorbitan Esters and PEG Sorbitan Esters. For such products, the HLB can be calculated using the following calculation:

\[
\text{HLB} = 20 \times (1 - S/A)
\]
Where $S =$ Saponification number of the ester (3)

$A =$ Acid number of the acid used to make the ester (4)

**Required HLB**

The required HLB of an oil is the HLB value of the surfactant that will provide the lowest interfacial tension between the oil phase and the water phase.

**Methodology**

**Determining the required HLB using the HLB kit:**

The HLB kit is comprised of surfactant blends with HLBS ranging from 2 to 16. To determine the required HLB of a lipophilic ingredient, a simple, practical test involving eight small experiments is run. The test involves the preparation of simple emulsions: each with the same amount of oil, the same amount of surfactants with different HLB values and the same amount of water. After all the components are added to jars, each is mixed to form a trial emulsion.

**Results**

After observing the trial emulsions, the HLB of the emulsifier or the emulsifier blend that produced the most stable system is the required HLB for the oil(s) used.

**Conclusion:**

The HLB system is a tool that makes the selection of nonionic emulsifiers easy. The HLB system allows the scientist to calculate the HLB value of a non-ionic emulsifier, as well as determine the required HLB for various water insoluble ingredients used in emulsions. When these are properly matched, stable formulations can easily be obtained.

The HLB system can help you save time and money during product development by helping you choose the best emulsifiers for your particular application.

It is an effective, time proven tool that helps the formulator navigate through the multitude of emulsifier options and narrows the range of emulsifiers that are best suited for the desired application.

**References:**


3. AOCS CD 3-25

4. AOCS CD 6-38 and AOCS Te LA -64