Hydrophilic Lipophilic Balance (HLB) Calculations

Pharmaceutics Lecture 11.1.07

What is the HLB value of a surfactant system composed of 10g Span 60 (HLB=4.7) and 20g Tween 60 (HLB=14.9)?

First, recognize the HLB is equivalent to concentration. Label the variables:

$Q_1 = 10g$ $\quad C_1 = 4.7$

$Q_2 = 20g$ $\quad C_2 = 14.9$

$Q_f = (10g + 20g) = 30g$ $\quad C_f = ??$

So now we're going to use the same equation we've been using for a while, rearrange it, and solve for C_f.

$$C_1Q_1 + C_2Q_2 = C_fQ_f$$

$$\frac{C_1Q_1 + C_2Q_2}{Q_f} = C_f = \frac{4.7 \times 10g + 14.9 \times 20g}{30g} = \underline{\underline{11.5}}$$

Rx		HLB
Mineral Oil	30g	12
Wool fat	1.5g	10
Cetyl alcohol	1g	15
Emulsifier	5g	
Water qs ad	90mL	

a) Calculate the required (final) HLB.

b) Using Tween 60 (HLB=14.9) and Span 60 (HLB=4.7), determine how much of each you need to fill this Rx. (see below)

Label our variables. Do not use the final volume as Q_f. When solving HLB problems consider only the oils (the guys with an HLB value).

$Q_1 = 30g$ $\quad C_1 = 12$

$Q_2 = 1.5g$ $\quad C_2 = 10$

$Q_2 = 1g$ $\quad C_2 = 15$

$Q_f = (30 + 1.5 + 1) = 32.5g$ $\quad C_f = ??$

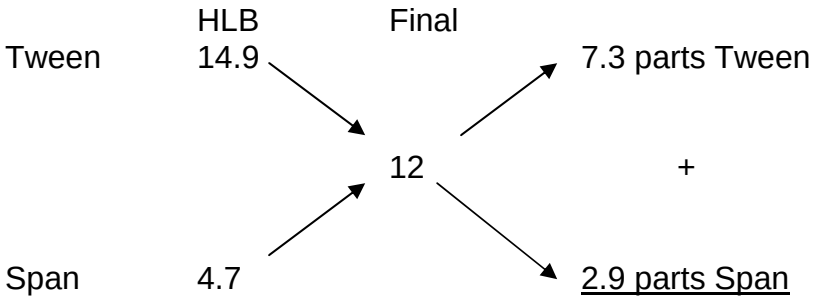
Rearrange the equation and solve.

$$C_1Q_1 + C_2Q_2 + C_3Q_3 = C_fQ_f$$

$$\frac{C_1Q_1 + C_2Q_2 + C_3Q_3}{Q_f} = C_f = \frac{12 \times 30g + 10 \times 1.5g + 15 \times 1g}{32.5g} = \underline{\underline{12}}$$

b) Using Tween 60 (HLB=14.9) and Span 60 (HLB=4.7) as emulsifiers, determine how much of each you need to fill this Rx.

The Rx above stated that we need 5g of emulsifier to fill this prescription. We will use the median allegation method to solve the problem (because it's easier). Remember we are trying to get a final HLB of 12.



So we need 5g of emulsifier with HLB=12. Determine the number of grams of each Tween and Span we need based on this mass.

$$\frac{5g\ HLB\,12}{}\times\left(\frac{7.3\ parts\ Tween}{10.2\ parts\ HLB\,12}\right)=\underline{\underline{3.6g\ Tween}}$$

$$\frac{5g\ HLB\,12}{}\times\left(\frac{2.9\ parts\ Tween}{10.2\ parts\ HLB\,12}\right)=\underline{\underline{1.4g\ Span}}$$

Or instead of doing the second calc, just subtract the number of grams of Tween from the total mass of the emulsifier.

$$5g-3.6g=1.4g\ Span$$

Rx		HLB
Mineral Oil	50% w/v	12
Cetyl alcohol	1g	15
Emulsifier	5% w/v	
Water qs ad	120mL	

a) Determine the required HLB.

b) Determine the amount of Tween 60 (HLB=14.9) and Span 60 (4.7) required to reach this HLB. (see below)

Before we label our variables we need to determine the mass of mineral oil used in the Rx. The Rx consists of 50% w/v mineral oil (50g/100mL) and is written for 120mL

$$\frac{120mL}{}\times\left(\frac{50g}{100mL}\right)=60g$$

Label the variables.

$Q_1 = 60g$ $\quad C_1 = 12$

$Q_2 = 1g$ $\quad C_2 = 15$

$Q_f = (60+1) = 61g$ $\quad C_f = ??$

Rearrange the equation and solve:

$$C_1Q_1 + C_2Q_2 = C_fQ_f$$

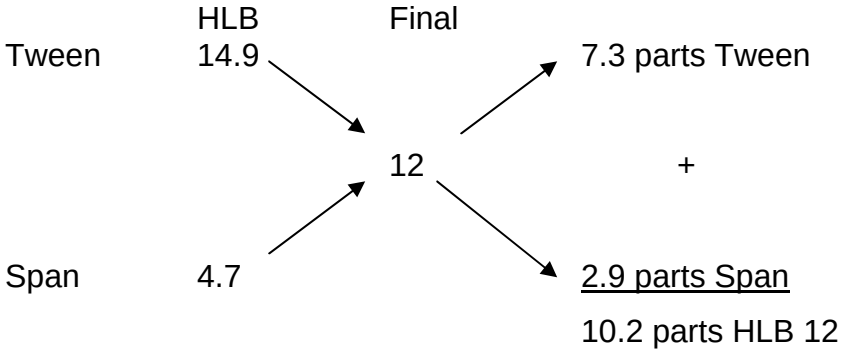
$$\frac{C_1Q_1 + C_2Q_2}{Q_f} = C_f = \frac{12\times 60g + 15\times 1g}{61g} = \underline{\underline{12.05}} \approx \underline{\underline{12}}$$

b) Determine the amount of Tween 60 (HLB=14.9) and Span 60 (4.7) required to reach this HLB.

First determine the number of grams of emulsifier required by this Rx. Above the prescription states that of the final 120mL 5% w/v is emulsifier.

$$\frac{120mL}{} \times \left(\frac{5g\ emulsifier}{100mL}\right) = 6g\ emulsifier$$

Remember the final HLB we calculated above is 12. Again we'll use median allegation method.



So we need 6g of emulsifier with HLB=12. Determine the number of grams of each Tween and Span we need based on this mass.

$$\frac{6g\ HLB\,12}{} \times \left(\frac{7.3\ parts\ Tween}{10.2\ parts\ HLB\,12}\right) = \underline{\underline{4.3g\ Tween}}$$

$$\frac{6g\ HLB\,12}{} \times \left(\frac{2.9\ parts\ Tween}{10.2\ parts\ HLB\,12}\right) = \underline{\underline{1.7g\ Span}}$$

HLB Worksheet from class

1. What is the HLB of an emulsion blend of 30% span 40 (HLB=6.7) and 70% tween 40 (HLB=15.6)?

Assume a total mass of 100g for ease of calculations.

Label the variables.

$Q_1 = 30g$ $\quad C_1 = 6.7$

$Q_2 = 70g$ $\quad C_2 = 15.6$

$Q_f = (30+70) = 100g$ $\quad C_f = ??$

Rearrange the equation and solve:

$$C_1Q_1 + C_2Q_2 = C_fQ_f$$

$$\frac{C_1Q_1 + C_2Q_2}{Q_f} = C_f = \frac{6.7\times 30g + 15.6\times 70g}{100g} = \underline{\underline{12.9}}$$

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2. a) What is the HLB of the following emulsion?

   b) Determine the amount of Tween 60 (HLB=14.9) and Span 60 (4.7) required to reach this HLB. (see below)

Rx		HLB
Cetyl alcohol	14g	15
White wax	1g	12
White petrolatum	10g	12
Emulsifier	6% w/w	
Water qs ad	100g	

Label the variables.

$Q_1 = 14g$ $\quad C_1 = 15$

$Q_2 = 1g$ $\quad C_2 = 12$

$Q_2 = 10g$ $\quad C_2 = 12$

$Q_f = (14+10+1) = 25g$ $\quad C_f = ??$

Rearrange the equation and solve:

$$C_1Q_1 + C_2Q_2 + C_3Q_3 = C_fQ_f$$

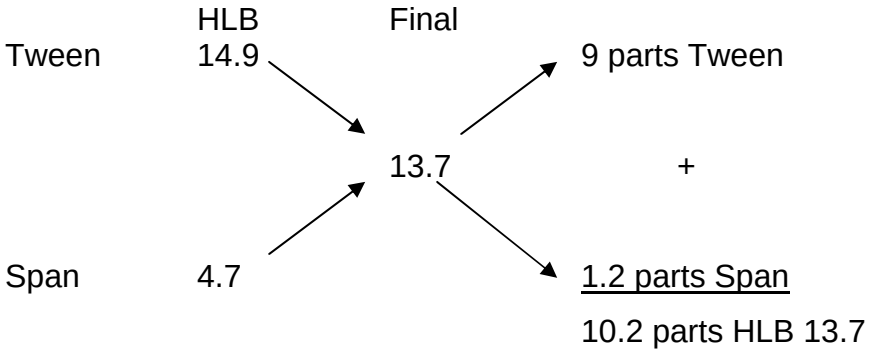
$$\frac{C_1Q_1 + C_2Q_2 + C_3Q_3}{Q_f} = C_f = \frac{15\times 14g + 12\times 1g + 12\times 10g}{25g} = \underline{\underline{13.7}}$$

b) Determine the amount of Tween 60 (HLB=14.9) and Span 60 (4.7) required to reach this HLB. (see below)

First determine the number of grams of emulsifier required by this Rx. Above the prescription states that of the final 100g 6% w/w is emulsifier.

$$\frac{100g}{} \times \left(\frac{6g\ emulsifier}{100g} \right) = 6g\ emulsifier$$

Remember the HLB we calculated above was 13.7.



So we need 6g of emulsifier with HLB=13.7. Determine the number of grams of each Tween and Span we need based on this mass.

$$\frac{6g\ HLB\,13.7}{} \times \left(\frac{9\ parts\ Tween}{10.2\ parts\ HLB\,13.7} \right) = \underline{\underline{5.29g\ Tween}}$$

$$\frac{6g\ HLB\,13.7}{} \times \left(\frac{1.2\ parts\ Tween}{10.2\ parts\ HLB\,13.7} \right) = \underline{\underline{0.71g\ Span}}$$

3. Calculate the required HLB for the oil phase of the following oil phase.

Rx	PARTS	HLB
Cetyl esters wax	12.5	15
White wax	12.0	12
Mineral oil	56.0	12

Label the variables.

$$Q_1 = 12.5\ parts \qquad C_1 = 15$$
$$Q_2 = 12\ parts \qquad C_2 = 12$$
$$Q_2 = 56\ parts \qquad C_2 = 12$$
$$Q_f = (12.5 + 12 + 56) = 80.5\ parts \qquad C_f = ??$$

Rearrange the equation and solve:

$$C_1Q_1 + C_2Q_2 + C_3Q_3 = C_fQ_f$$
$$\frac{C_1Q_1 + C_2Q_2 + C_3Q_3}{Q_f} = C_f = \frac{15 \times 12.5\ parts + 12 \times 12\ parts + 12 \times 56\ parts}{80.5\ parts} = \underline{\underline{12.5}}$$