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 \( C_f \).

\[
\frac{C_1 Q_1 + C_2 Q_2}{Q_f} = C_f = \frac{4.7 \times 10g + 14.9 \times 20g}{30g} = 11.5
\]

<table>
<thead>
<tr>
<th>Rx</th>
<th>HLB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mineral Oil</td>
<td>30g</td>
</tr>
<tr>
<td>Wool fat</td>
<td>1.5g</td>
</tr>
<tr>
<td>Cetyl alcohol</td>
<td>1g</td>
</tr>
<tr>
<td>Emulsifier</td>
<td>5g</td>
</tr>
<tr>
<td>Water</td>
<td>qs</td>
</tr>
</tbody>
</table>

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.

\[
\frac{C_1 Q_1 + C_2 Q_2 + C_3 Q_3}{Q_f} = C_f = \frac{12 \times 30g + 10 \times 1.5g + 15 \times 1g}{32.5g} = 12
\]
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.

\[
\begin{align*}
\text{Tween} & : 14.9 \text{ HLB} & 7.3 \text{ parts Tween} \\
\text{Final} & : 12 \text{ HLB} & 10.2 \text{ parts HLB 12} \\
\text{Span} & : 4.7 \text{ HLB} & 2.9 \text{ parts Span}
\end{align*}
\]

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.

\[
\begin{align*}
\frac{5g \text{ HLB 12}}{} \times \frac{7.3 \text{ parts Tween}}{10.2 \text{ parts HLB 12}} &= 3.6g \text{ Tween} \\
\frac{5g \text{ HLB 12}}{} \times \frac{2.9 \text{ parts Tween}}{10.2 \text{ parts HLB 12}} &= 1.4g \text{ Span}
\end{align*}
\]

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

\[5g - 3.6g = 1.4g \text{ Span}\]

<table>
<thead>
<tr>
<th>Rx</th>
<th>HLB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mineral Oil</td>
<td>50% w/v</td>
</tr>
<tr>
<td>Cetyl alcohol</td>
<td>1g</td>
</tr>
<tr>
<td>Emulsifier</td>
<td>5% w/v</td>
</tr>
<tr>
<td>Water</td>
<td>qs ad 120mL</td>
</tr>
</tbody>
</table>

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

\[
\frac{120mL}{100mL} \times \frac{50g}{100mL} = 60g
\]
Label the variables.

\[ Q_1 = 60\, g \quad C_1 = 12 \]
\[ Q_2 = 1\, g \quad C_2 = 15 \]
\[ Q_f = (60 + 1) = 61\, g \quad C_f = ?? \]

Rearrange the equation and solve:

\[ C_1 Q_1 + C_2 Q_2 = C_f Q_f \]
\[ \frac{C_1 Q_1 + C_2 Q_2}{Q_f} = C_f = \frac{12 \times 60 + 15 \times 1}{61} \approx 12.05 \approx 12 \]

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.

\[ \frac{120\, mL}{100\, mL} \times \left( \frac{5 \, g \, \text{emulsifier}}{100\, mL} \right) = 6\, g \, \text{emulsifier} \]

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.

\[ \frac{6\, g \, \text{HLB 12}}{10.2 \, \text{parts HLB 12}} \times \left( \frac{7.3 \, \text{parts Tween}}{10.2 \, \text{parts HLB 12}} \right) = 4.3\, g \, \text{Tween} \]
\[ \frac{6\, g \, \text{HLB 12}}{10.2 \, \text{parts HLB 12}} \times \left( \frac{2.9 \, \text{parts Tween}}{10.2 \, \text{parts HLB 12}} \right) = 1.7\, g \, \text{Span} \]
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.

\[
\begin{align*}
Q_1 &= 30g \\
C_1 &= 6.7 \\
Q_2 &= 70g \\
C_2 &= 15.6 \\
Q_f &= (30 + 70) = 100g \\
C_f &= ??
\end{align*}
\]

Rearrange the equation and solve:

\[
C_1Q_1 + C_2Q_2 = C_fQ_f
\]

\[
\frac{C_1Q_1 + C_2Q_2}{Q_f} = C_f = 6.7\times30g + 15.6\times70g = \frac{1290g}{100g} = 12.9
\]

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)

<table>
<thead>
<tr>
<th>Rx</th>
<th>HLB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cetyl alcohol</td>
<td>14g</td>
</tr>
<tr>
<td>White wax</td>
<td>1g</td>
</tr>
<tr>
<td>White petrolatum</td>
<td>10g</td>
</tr>
<tr>
<td>Emulsifier</td>
<td>6%</td>
</tr>
<tr>
<td>Water</td>
<td>qs ad</td>
</tr>
</tbody>
</table>

Label the variables.

\[
\begin{align*}
Q_1 &= 14g \\
C_1 &= 15 \\
Q_2 &= 1g \\
C_2 &= 12 \\
Q_2 &= 10g \\
C_2 &= 12 \\
Q_f &= (14 + 10 + 1) = 25g \\
C_f &= ??
\end{align*}
\]

Rearrange the equation and solve:

\[
C_1Q_1 + C_2Q_2 + C_3Q_3 = C_fQ_f
\]

\[
\frac{C_1Q_1 + C_2Q_2 + C_3Q_3}{Q_f} = C_f = \frac{15\times14g + 12\times1g + 12\times10g}{25g} = 13.7
\]
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.

\[
\frac{100g}{6g \text{ emulsifier}} \times \left( \frac{6g \text{ emulsifier}}{100g} \right) = 6g \text{ emulsifier}
\]

Remember the HLB we calculated above was 13.7.

<table>
<thead>
<tr>
<th>Tween</th>
<th>HLB</th>
<th>Final</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>14.9</td>
<td>9 parts Tween</td>
</tr>
<tr>
<td></td>
<td></td>
<td>13.7 +</td>
</tr>
<tr>
<td>Span</td>
<td>4.7</td>
<td>1.2 parts Span</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10.2 parts HLB 13.7</td>
</tr>
</tbody>
</table>

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.

\[
\frac{6g \text{ HLB 13.7}}{9 \text{ parts Tween}} \times \left( \frac{9 \text{ parts Tween}}{10.2 \text{ parts HLB 13.7}} \right) = 5.29g \text{ Tween}
\]

\[
\frac{6g \text{ HLB 13.7}}{1.2 \text{ parts Tween}} \times \left( \frac{1.2 \text{ parts Tween}}{10.2 \text{ parts HLB 13.7}} \right) = 0.71g \text{ Span}
\]
3. Calculate the required HLB for the oil phase of the following oil phase.

<table>
<thead>
<tr>
<th>Rx</th>
<th>PARTS</th>
<th>HLB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cetyl esters wax</td>
<td>12.5</td>
<td>15</td>
</tr>
<tr>
<td>White wax</td>
<td>12.0</td>
<td>12</td>
</tr>
<tr>
<td>Mineral oil</td>
<td>56.0</td>
<td>12</td>
</tr>
</tbody>
</table>

Label the variables.

\[ Q_1 = 12.5 \text{ parts} \quad \quad C_1 = 15 \]
\[ Q_2 = 12 \text{ parts} \quad \quad C_2 = 12 \]
\[ Q_3 = 56 \text{ parts} \quad \quad C_2 = 12 \]
\[ Q_f = (12.5 + 12 + 56) = 80.5 \text{ parts} \quad \quad C_f = ?? \]

Rearrange the equation and solve:

\[ C_1 Q_1 + C_2 Q_2 + C_3 Q_3 = C_f Q_f \]
\[ \frac{C_1 Q_1 + C_2 Q_2 + C_3 Q_3}{Q_f} = C_f = \frac{15 \times 12.5 \text{ parts} + 12 \times 12 \text{ parts} + 12 \times 56 \text{ parts}}{80.5 \text{ parts}} = 12.5 \]