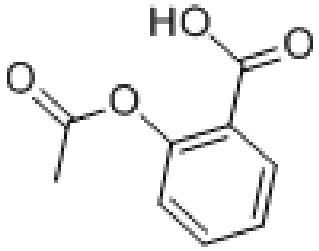
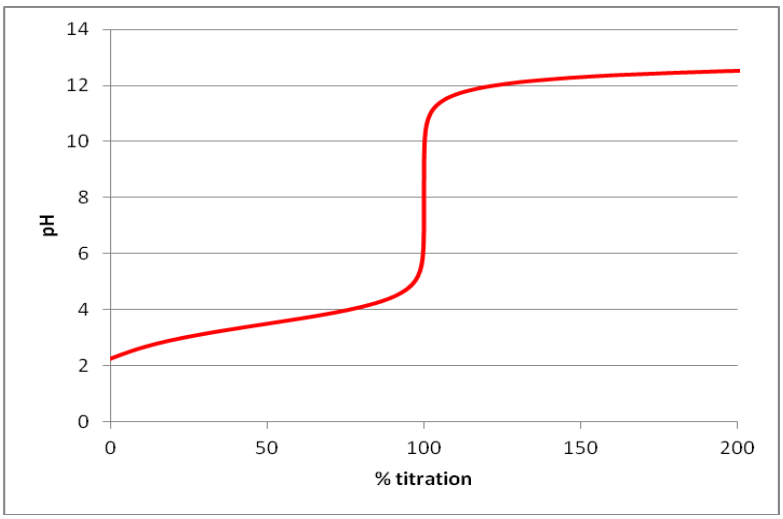
8C. Acid-base determination of acetylsalicylic acid in tablets

Aspirin is the trade name of drugs containing organic chemical compound named acetylsalicylic acid. It is widely used as an analgesic to relieve minor aches and pains, as an antipyretic to reduce fever, and as an anti-inflammatory medication. It also has an antiplatelet effect and because of that is used to prevent heart attacks, strokes, and blood clot formation in people at high risk of developing blood clots. Acetylsalicylic acid was first isolated by Felix Hoffmann, a chemist working for the German company *Friedrich Bayer & Co* in 1897. Produced under the name "Aspirin" it was the first drug obtained synthetically. Its synthesis is recognized as the beginning of the pharmaceutical industry. The best way of applying it are tablets covered by acid-resistant envelope – here the active compound is released not in stomach but in intestines, protecting the stomach mucous membrane. Aspirin should be used with moderation, because the mucous membrane of intestines can also be damaged, causing bleeding from the alimentary canal.



Acetylsalicylic acid

Chemically, aspirin is monoprotic acid and its strength (pKa=3.5) is comparable to that of formic acid. It solubility in water is not high (ca. 3.3 g/L at 20°C).
In this exercise, students analyze tablets containing acetylsalicylic acid and calculate the content of the active component $C_8H_7O_2COOH$.
Tablets contain also other components, for example fillers (typically starch) which however do not obscure the endpoint. That makes the analysis relatively simple and does not differ too much from that of, say, acetic acid (pKa=4.8).



Titration curve of 0.1 M acetylsalicylic acid using 0.1 M NaOH as titrant

It is clear that the proper indicator for this analysis is, among others, Phenylphthalein, which changes color to red starting at pH=8.3.
Because of limited solubility of acid it is rational to apply reverse titration instead of the direct one. Its idea is adding to the sample the known amount of moles of NaOH in solution in excess relating to the amount of acid. The excess of base can be determined by titration using a strong acid as titrant (HCl or H_2SO_4). This titration is characterized by big jump in pH close to the stoichiometric point, what allows to use a range of

indicators without limiting the accuracy of the analysis. So, both Methyl Orange and Phenolphthalein are useful.

Procedure

1. Pour ca. 50 mL of distilled water to an Erlenmayer flask. Temperature should be ca. 60° (hot, but does not burn).
2. Put the tablet in the flask and crush it using the glass rod. Cool down the solution. Add water to the total volume 100-150 mL.
3. Add 50 mL of NaOH solution (ca. 0.1 M, prepared by yourself before – exercise no. 8) and 2-3 drops of indicator (Phenolphthalein).
4. Titrate the content using 0.1 M HCl until red color of Phenolphthalein disappears.

Make at least two independent titrations.

If enough time, try also direct titration using your NaOH solution and compare the result with that from reverse method.

Calculations

Calculate the masses of acid, independent for the titrations, and their arithmetic mean. Compare the final result with that given by producer (usually it is 75-500 mg, the value will be given by your teacher after completing the analysis).

Note that this is quantitative determination. It is important during measurements and calculations to record data with proper number of significant figures.

Molecular mass of acetylsalicylic acid is 180.16 g/mole.

Report: Note All the data and calculations. Compare your result with information provided by the producer.

The same titration can be done pehametrically.

Procedure (pH-metric titration)

1. Repeat points 1 and 2 as above.
2. Add exactly 50 mL of NaOH solution.
3. Place the beaker on magnetic stirrer, insert the magnet in it, as well as pH-electrode. Ask the assistant to control the correctness of the installation and some advices.
4. Measure and note pH. Repeat this adding small portions of the titrant NaOH (few drops each), noting also the actual volume of titrant added (total). Finish titration when pH exceeds ca. 12.

Processing the results

Using a computer data-sheet, plot the titration curve obtained and determine as exactly as possible the volume of titrant corresponding to the inflection point.

For more aspiring students: The preciseness of determination of the inflection point can be very improved if calculating the second derivative of the titration curve. Ask your teacher for details if want to try this procedure.

Report: Record all the numbers obtained, as well as the calculations made. Note your observation concerning the comparison of your result with the factory value.

Sources:
internet, In particular Wikipedia
textbooks