

Analysis of Aspirin Tablets

Introduction

For a long time the bark of the willow tree (*salix alba*) was used as a traditional medicine to relieve the fever symptoms of malaria. In the 1860's chemists showed that the active ingredient in willow bark is salicylic acid (2-hydroxybenzoic acid) and by 1870 salicylic acid was in wide use as a pain killer (analgesics are drugs which relieve pain), and a fever depressant (antipyretics are drugs which lower body temperature).

However, salicylic acid is relatively a strong acid, it has the undesirable side effect of irritating and damaging the mouth, esophagus and stomach membranes.

In 1889 the Bayer Company of Germany introduced the ethanoate ester of salicylic acid, naming it 'Aspirin'. Since that time mild analgesics containing aspirin have appeared under many different brand names.

The main constituent of aspirin tablets is 2 – ethanoylhydroxybenzoic acid (acetylsalicylic acid, $\text{CH}_3\text{COOC}_6\text{H}_4\text{COOH}$).

The acidic conditions in the stomach do not affect aspirin.

However, the alkaline juices in the intestines hydrolyse aspirin to ethanoate to 2 – hydroxybenzoate (salicylate) ions.

Hydroxybenzoates lower body temperature quickly and very effectively in fever patients, but they have little or no effect if the temperature is normal.

They are also analgesics, which relieve pain, such as headaches.

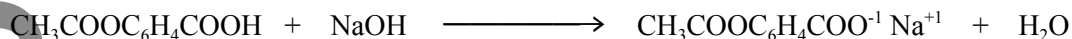
The toxic dose from hydroxybenzoates is relatively large; their uncontrolled use could be dangerous.

Acetylsalicylic acid, i.e. 2 – ethanoylhydroxybenzoic acid, $\text{CH}_3\text{COOC}_6\text{H}_4\text{COOH}$, is a very large molecule with only one O – H group to provide hydrogen bonding, hence not very soluble in a polar solvent such as water, but is soluble in a organic polar solvent such as ethanol.

Purpose

The objective of this experiment is to determine the percentage of 2 – ethanoylhydroxybenzoic acid (acetylsalicylic acid, $\text{CH}_3\text{COOC}_6\text{H}_4\text{COOH}$), present in aspirin tablets that are available over-the-counter; and then to compare with the quantity stated on the box.

The analysis makes use of the fact that aspirin is a monoprotic acid and therefore reacts with sodium hydroxide according to the following equation:



A solution of known mass of aspirin will be prepared using ethyl alcohol, and this will be titrated against a standard solution of sodium hydroxide, using phenolphthalein as an indicator, to the equivalence point. Knowing the volume of standard sodium hydroxide required for the titration, the number of moles of the alkali can be calculated, and from the above equation the amount in moles of acetylsalicylic acid which was in the sample can be determined. Thus, the mass of the aspirin in the original titrated sample may be determined. Once the grams of aspirin in the titrated sample are known, it is thus possible to determine the percent of acetylsalicylic acid, $\text{CH}_3\text{COOC}_6\text{H}_4\text{COOH}$ per an aspirin tablet.

number of moles of NaOH used = number of moles of acetylsalicylic acid, aspirin neutralized

mass of, acetylsalicylic acid aspirin in original sample = number of moles x molar mass of acetylsalicylic acid, $\text{CH}_3\text{COOC}_6\text{H}_4\text{COOH}$

percent of aspirin in sample = (mass of aspirin in sample ÷ total mass of aspirin tablet) x 100

(Recall: **Titration**: a controlled reaction between a compound in which the number of moles of one reactant is known (the **titrant**, a primary standard) and a measured volume of solution (dispensed from a burette) in which the number of moles of a different reactant is unknown (the **analyte**). The analyte's concentration (moles/L) is then determined from the stoichiometry of the reaction and the volume of analyte dispensed from the burette.)

Materials

0.100 mol dm⁻³ NaOH_(aq), 2 ASA tablets, ethanol (50 cm³ of 95 % alcohol), phenolphthalein indicator, mortar and pestle, retort stand, burette with burette clamp, 3 Erlenmeyer flasks (250 cm³), 2 beakers (250 cm³), wash bottle with distilled water, glass rod, balance.

Procedure

1. Rinse a clean burette with a small amount of 0.100 mol dm⁻³ sodium hydroxide solution.
2. Fill a burette with 0.100 mol dm⁻³ sodium hydroxide solution and set it up in the burette stand. Allow some of the solution to drain into a waste beaker so that no air remains in the tip of the burette. (Make sure there are no air bubbles in the burette.)
3. Record the initial burette reading in the Data Table.
4. Mass one aspirin tablet, record the mass in the Data Table, crush the tablet using the pestle and mortar into a fine powder.
5. Place the powdered tablet into an Erlenmeyer flask, and dissolve it ~ 10 – 15 cm³ of alcohol. Swirl the flask until the aspirin dissolves.
6. Add 3 – 4 drops of phenolphthalein indicator to the aspirin tablet solution.
7. Titrate with the 0.100 mol dm⁻³ NaOH_(aq) until a persistent pale pink is observed. (Note: All tablet medications contain “inert” or “contaminants” ingredients as well as medicinal ones intentionally added by the drug companies will not dissolve in the alcohol solution, so it will appear cloudy. This will not affect the titration.)
8. Record the final burette reading.
9. Repeat the titration with the second aspirin tablet provided.
10. Clean and return all equipment.

Data Collection

Create suitable Data Tables for this experiment.

Data Processing

Determine the moles of NaOH_(aq), moles of acetylsalicylic acid (ASA) titrated in each tablet, mass of acetylsalicylic acid(ASA) in each tablet, hence the percentage of acetylsalicylic acid (ASA) in the aspirin tablet.

Compare the mass of acetylsalicylic acid, (ASA) aspirin in the tablet that was determined by your experiment to the value claimed by the manufacturer on the box.

What sources of error were incurred in this experiment and how might they have affected your results?

Why are some ASA tablets coated or buffered?

What other ingredients are included in an aspirin tablet ?