Determination of the percentage (w/v) of hypochlorite in bleach

Theory

Many commercial bleaches are simply solutions of hypochlorite salts such as sodium hypochlorite (NaOCl) or calcium hypochlorite ($Ca(OCl)_2$). Hypochlorite ion reacts with excess iodide ion in the presence of acid to generate an iodine solution:

$$ClO^- + 2I^- + 2H^+ \rightarrow Cl^- + I_2 + H_2O$$

The liberated iodine solution can be titrated against sodium thiosulfate solution using a freshly prepared starch solution as indicator. The titration reaction may be represented by the equation:

$$I_2 + 2S_2O_3^{2-} \rightarrow 2I^- + S_4O_6^{2-}$$

Starch indicator is added during the titration when the colour of the solution in the conical flask fades to a **pale** yellow colour. The solution becomes blue-black, and the titration is continued until it goes colourless.

Procedure

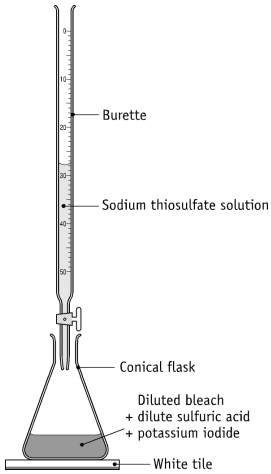
NB: Wear your safety glasses.

The bleach solution must first be diluted to make a solution of suitable concentration for the titration. Using a pipette, add 25 cm^3 of bleach to a 250 cm^3 volumetric flask, and make the solution up to the mark with deionised water. The flask should be stoppered and inverted several times.

Wash the pipette, burette and conical flask with deionised water. Rinse the pipette with the diluted bleach solution and the burette with the sodium thiosulfate solution.

Using a pipette filler, fill the pipette with the diluted bleach solution and transfer the contents of the pipette to the conical flask.

Add 1 g potassium iodide and 10 cm^3 of dilute sulfuric acid to the conical flask – this liberates iodine.



Using a funnel, fill the burette with sodium thiosulfate solution, making sure that the part below the tap is filled before adjusting to zero.

With the conical flask standing on a white tile, add the solution from the burette to the flask. Swirl the flask continuously and occasionally wash down the walls of the flask with deionised water using a wash bottle.

Add a few drops of the starch indicator solution just prior to the end-point, when the colour of the solution fades to **pale** yellow. A blue-black colour appears. The thiosulfate solution should now be added dropwise, with thorough swirling.

The end-point of the titration is detected when the blue-black colour changes to colourless. Note the burette reading.Repeat the procedure, adding the sodium thiosulfate solution dropwise approaching the end-point, until two titres agree to within 0.1 cm^3.

Calculate the concentration of the iodine solution.Calculate the concentration of hypochlorite in the bleach solution.
Calculate the percentage (w/v) of hypochlorite in the bleach solution.

Specimen Results (for sodium hypochlorite solution)

Rough titre	= 22.6cm^3
Second titre	= 22.4 cm^3
Third titre	= 22.5 cm^3
Average of accurate titres	= 22.45 cm^3
Volume of diluted bleach used to release iodine	= 25.0 cm^3
Concentration of sodium thiosulfate solution	= 0.1 M

Specimen Calculations

$$V_A \times M_A \times n_B = V_B \times M_B \times n_A$$

$25.0 \times M_A \times 2 = 22.45 \times 0.1 \times 1$

$M_A = 22.45 \times 0.1 \times 1 / (25.0 \times 2)$
$= 0.0449$

Concentration of hypochlorite in diluted bleach solution = 0.0449 M
Concentration of hypochlorite in undiluted bleach solution
= 0.0449 x 10 M
= 0.449 M
Percentage (w/v) of hypochlorite in bleach = 74.5 x 0.449 / 10
= 3.35%

Specimen Results (for Parazone thin bleach)

Rough titre	= 29.1 cm^3
Second titre	= 28.9 cm^3
Third titre	= 28.9 cm^3
Average of accurate titres	= 28.9 cm^3
Volume of diluted bleach used to release iodine	= 25.0 cm^3
Concentration of sodium thiosulfate solution	= 0.1 M

Specimen Calculations

Using the formula method,
Concentration of hypochlorite in diluted bleach solution = 0.0578 M
Therefore, concentration of hypochlorite in undiluted bleach solution
= 0.0578 x 10 M
= 0.578 M
Percentage (w/v) of hypochlorite (NaOCl) in bleach
= 74.5 x 0.578 / 10
= 4.31%

student questions

Give one reason why, in making up the solution of diluted bleach, a volumetric flask is preferable to a graduated cylinder.
A volumetric flask is quite an accurate measuring vessel, whereas a graduated cylinder is not.

A burette, a pipette and a conical flask were used in the titration. State the correct washing procedures for each of these items before starting the titration.
Rinse the burette, pipette and conical flask respectively with deionised water. Rinse the burette with sodium thiosulfate solution, and rinse the pipette with diluted bleach solution.

Why could you not use hydrochloric acid when acidifying the bleach?
Hydrochloric acid is not suitable, as it will react with hypochlorite to liberate chlorine gas.

Extension Work

Analysis of a different brand of bleach may be done, using the same method, and the results compared.