

Determination of manganese in a fertiliser

Student worksheet

In this activity you will determine the amount of manganese in a fertiliser.

Equipment and materials

- 250 cm³ conical flask x 2
- Balance (if using solid fertiliser)
- 5 cm³ pipette (if using liquid fertiliser)
- 10 cm³ pipette
- 25 cm³ measuring cylinder
- 100 cm³ volumetric flasks
- 250 cm³ volumetric flask x 6 (or thoroughly wash and re-use)
- Bunsen burner, tripod and gauze
- Burette
- Colorimeter and suitable filter (green) - a solution of manganate(VII) ions displays maximum absorption at 530 nm.
- Fertiliser sample, solid fertiliser (5 g) or liquid fertiliser (5 cm³)
- Concentrated nitric acid, concentrated (25 cm³)
- Potassium iodate(VII) (potassium periodate) (4 g)
- Potassium manganate(VII) solution, 0.005 mol dm⁻³ (37.5 cm³)

Method

Care: Wear eye protection and chemical-resistant gloves. Concentrated nitric(V) acid is corrosive. Potassium iodate(VII) (potassium periodate) is an irritant. The reaction of fertiliser with nitric acid generates nitrogen oxides (NO and NO₂) which are **very toxic** by inhalation. You must work in a fume cupboard when directed to do so.

Sample Preparation

1. If you are using a solid pellet (or slow release fertiliser), accurately weigh 5 g of solid fertiliser into a 250 cm³ conical flask
2. In a fume cupboard, use a measuring cylinder to add 20 cm³ of concentrated nitric acid to the flask.
3. If necessary, heat the flask gently in the fume cupboard until the sample has dissolved. (If not all of the solid has dissolved, filter off the undissolved solid after step 4).
4. Add about 150 cm³ of deionised water to the flask.
5. Transfer the solution to a 250 cm³ volumetric flask and make up to the mark with deionised water
6. If you are using a liquid fertiliser, shake it well, then pipette 5 cm³ into a 250 cm³ volumetric flask and make up to the mark with deionised water.

Oxidation to manganate(VII)

1. Pipette a 20 cm³ sample of your diluted fertiliser into a 250 cm³ conical flask.
2. In a fume cupboard use a measuring cylinder to add 5 cm³ of concentrated nitric acid and then add about 2 g of potassium iodate(VII) (potassium periodate). Both the nitric acid and iodate(VII) are added in excess, so the precise amounts do not matter.
3. In the fume cupboard, dilute the solution in the flask to about 50 cm³ with deionised water, and boil it for 10 minutes. If no purple colour is observed, remove the solution from the heat and

add another 1 g potassium iodate(VII), then reheat the solution to boiling. It may take more than 10 minutes for the colour to develop.

- Allow the solution to cool.
- Once the solution is cool, transfer it to a 100 cm³ volumetric flask and make up to the mark with deionised water.

Constructing and using a calibration curve

- Fill a burette with 0.005 mol dm⁻³ potassium manganate(VII) solution.
- Label five 250 cm³ volumetric flasks A to E (or use one, thoroughly washing it between samples) and add the volumes of manganate(VII) solution shown in the table, making the solution up to the mark with deionised water:

Volumetric flask	A	B	C	D	E
Volume of 0.005 mol dm ⁻³ manganate(VII) solution / cm ³	2.5	5.0	7.5	10.0	12.5
[MnO ₄ ⁻] / mol dm ⁻³ x 10 ⁻⁴	0.5	1.0	1.5	2.0	2.5

- Measure the absorbance of each of the five solutions of potassium manganate(VII) and also the absorbance of the fertiliser solution in the 100 cm³ flask.
- Plot a graph of absorbance (y axis) against manganate(VII) ion, MnO₄⁻(aq), concentration (x axis) for the five potassium manganate(VII) solutions A to E.
- Use the graph to find the concentration of MnO₄⁻(aq) in the fertiliser solution in the 100 cm³ flask.

Calculations

- Calculate the number of moles of manganese in 100 cm³ of the fertiliser solution that you used in the colorimeter.
- Calculate the number of moles of manganese in the 250 cm³ volumetric flask of diluted fertiliser solution.
- Calculate the mass of manganese in the sample of fertiliser that you used.
- Calculate the percentage of manganese in the original fertiliser.