Preparation of magnesium sulfate

Student worksheet

Making magnesium sulfate

Magnesium sulfate is a complex fertiliser. This simple salt is a source of two nutrients – magnesium and sulfur.

Magnesium sulfate occurs naturally as the mineral kieserite, $MgSO_4.H_2O$. This is dissolved in water (usually hot) and the purified sulfate is obtained by crystallisation from solution. Industrially, the crystals are centrifuged, dried and sieved.

It is also prepared from magnesium oxide. This is obtained by the thermal decomposition of:

- magnesium hydroxide (obtained from sea water):

$$Mg(OH)_2(s) \rightarrow MgO(s) + H_2O(g)$$

- magnesium carbonate (from the ore magnesite):

$$MgCO_3(s) \rightarrow MgO(s) + CO_2(g)$$

In either case, the oxide is reacted with sulfuric acid to produce magnesium sulphate:

$$MgO(s) + H_2SO_4(aq) \rightarrow MgSO_4(aq)$$

Magnesium sulfate-7-water, $MgSO_4.7H_2O$, crystals are obtained by evaporation. They may be recrystallised to increase purity.

You can make magnesium sulfate-7-water in the laboratory by reacting magnesium oxide with dilute sulfuric acid.

Equipment and materials

- Weighing bottle (or small beaker)
- Balance
- Evaporating basin
- 250 cm^3 beaker
- Bunsen burner, tripod and gauze
- 25 cm^3 measuring cylinder
- Filter funnel and filter paper
- Hot water bath
- Watch glass
- Thermometer (10 – 110 °C)
- Stirring rod
- 250 cm^3 beaker to act as a water bath
- Sample bottle
- Spatula
- 1 mol dm^{-3} sulfuric acid, 25 cm^3
- Magnesium oxide, 1.5 g

Method

Care: Wear eye protection. 1 mol dm^{-3} sulfuric acid is an irritant.

1. Weight out about 1.5 g magnesium oxide.
2. Using a measuring cylinder, measure 25 cm^3 of 1 mol dm^{-3} sulfuric acid into a 100 cm^3 conical flask.
3. Warm the acid to about 60 °C and, while stirring the acid, add magnesium oxide a little at a time. Make sure each portion dissolves before adding more. After about 1 g no more will dissolve and you will see a cloudy suspension in the beaker.

4. Filter the warm mixture into an evaporating basin and evaporate the filtrate slowly over a hot water bath at about 60 °C until crystals form.
5. Allow the concentrated solution to cool.
6. Filter off the crystals and put the filter paper and crystals on a watch glass and dab dry with another piece of filter paper. Cover the crystals with a piece of clean filter paper and leave them to dry at room temperature.
7. Label a sample tube with the name of the product, your name and the date. Weigh the labelled sample tube and record its mass.
8. Tip your dry product into the sample tube. Weigh the tube again. Record its mass.

Calculations

You used an excess of magnesium oxide and so the theoretical yield depends on the volume of 1 mol dm^{-3} sulfuric acid used.

From the equation

$$MgO(s) + H_2SO_4(aq) \rightarrow MgSO_4(aq) + H_2O(l)$$

1 mole of sulfuric acid produces 1 mole of magnesium sulfate

Calculate

- the number of moles of H_2SO_4 in 25 cm^3 of 1 mol dm^{-3} sulfuric acid;
- the number of moles of $MgSO_4$ that can be made;
- the theoretical yield of magnesium sulfate-7-water, $MgSO_4.7H_2O$;
- the percentage yield of magnesium sulfate-7-water, $MgSO_4.7H_2O$.