

Making sodium carbonate

Sodium carbonate is a very useful material. About one million tonnes of it is made each year in the UK – all by the Brunner Mond company in Cheshire. Although it is a white powder, most of it is used in making glass. This involves mixing it with sand and other substances and heating it. To make sodium carbonate, Brunner Mond uses two raw materials:

- ▼ salt (chemical name sodium chloride) which is found in underground deposits close to their factory; and
- ▼ limestone (chemical name calcium carbonate), which is quarried in Derbyshire.

The lime cycle

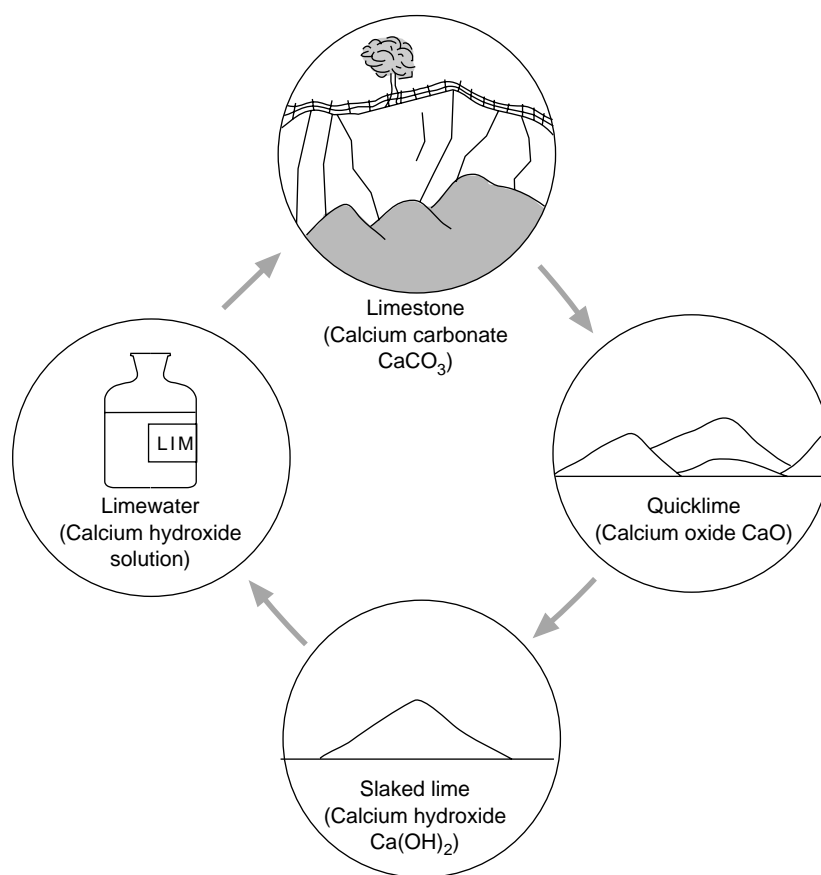


Fig 1 The Lime cycle

Figure 1 shows a cycle of chemical reactions starting with limestone. These turn limestone into other substances and finally back to calcium carbonate. Some of these reactions are used by Brunner Mond when it makes sodium carbonate.

Experiment

You can try some of these reactions yourself. You must wear eye protection.

1. Take a small chip of calcium carbonate and place it on a clean tin lid standing on a heatproof mat. Heat the chip strongly for a few minutes using the hottest part of a roaring Bunsen flame, Figure 2. Note the burner air hole should be open, and remember that the hottest part of a Bunsen flame is just beyond the blue cone.

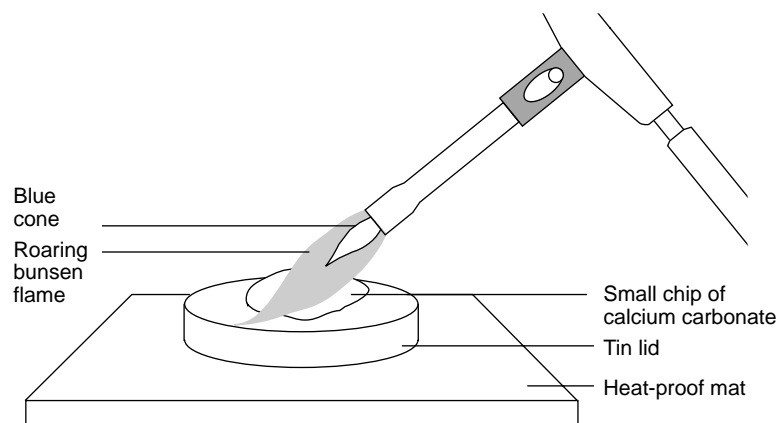


Fig 2

Does the limestone still look the same? Write down anything you observe.

- Let the limestone chip cool (this may take a few minutes – be patient). Use tongs to place the chip in a small beaker and add water from a dropper one drop at a time *Figure 3*.

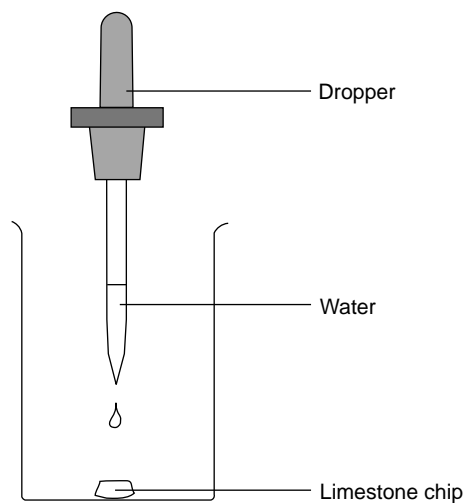


Fig 3

Write down your observations.

- Now add more water – about 15 cm³ – *Figure 4*, and stir with a glass rod to make a solution. There will still be a lot of unchanged limestone left.

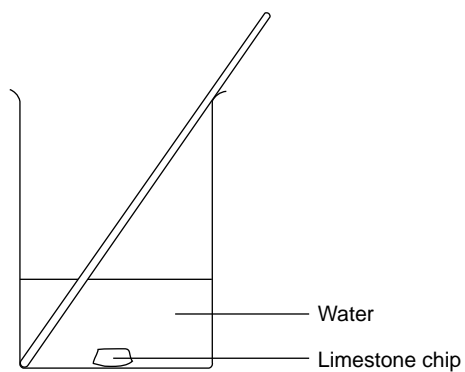


Fig 4

4. Filter your solution into a test tube, *Figure 5*. The solution should be clear. If it is not, filter it again. Use Universal Indicator paper to find the pH of the solution.

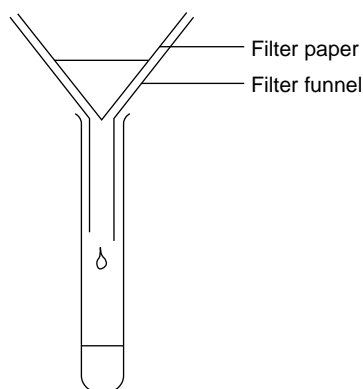


Fig 5

5. Gently blow into your clear solution with a straw, *Figure 6*. Do not suck! Describe what you see.

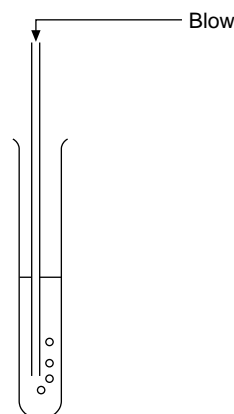


Fig 6

The Solvay process for making sodium carbonate

Brunner Mond uses the carbon dioxide that it gets from heating limestone and reacts it with a solution containing salt (sodium chloride) and ammonia. This process is named after the Belgian chemist, Ernst Solvay who developed it in the 1860s.

At their factory in Cheshire, Brunner Mond does this reaction in huge towers, about the size of six coaches stacked on top of each other. They filter off the cloudy solid, which is called sodium hydrogencarbonate (sometimes called sodium bicarbonate or bicarbonate of soda). They can sell some of this, and the rest is heated to turn it into sodium carbonate.

Sodium hydrogencarbonate and sodium carbonate are used in a number of everyday products and are sometimes labelled as E500.

Try to find out how these compounds are used. Look for any of their names or the code E500 on packs of products at home. You could try food products (in the kitchen), cosmetics and personal care products (in the bathroom cabinet), cleaning products (under the sink) and medicines. Do take care during your search and put things back! During your search you could also look for products containing calcium chloride, which is also made in the same process, and calcium carbonate itself.

You could make a poster with pictures of the products or cut out and stick on the actual labels (only when the packs are empty!).

Questions

1. Using *Figure 1* to help you, write a word equation to describe the reaction which occurs when you heat calcium carbonate.
2. Using *Figure 1* to help you, write a word equation to describe the reaction between calcium oxide and water.
3. When you blow into the limewater, you are adding carbon dioxide from your breath. Write a word equation to describe the reaction which occurs. What is the cloudiness you see?
4. Write symbol equations for the reactions in questions 1–3.

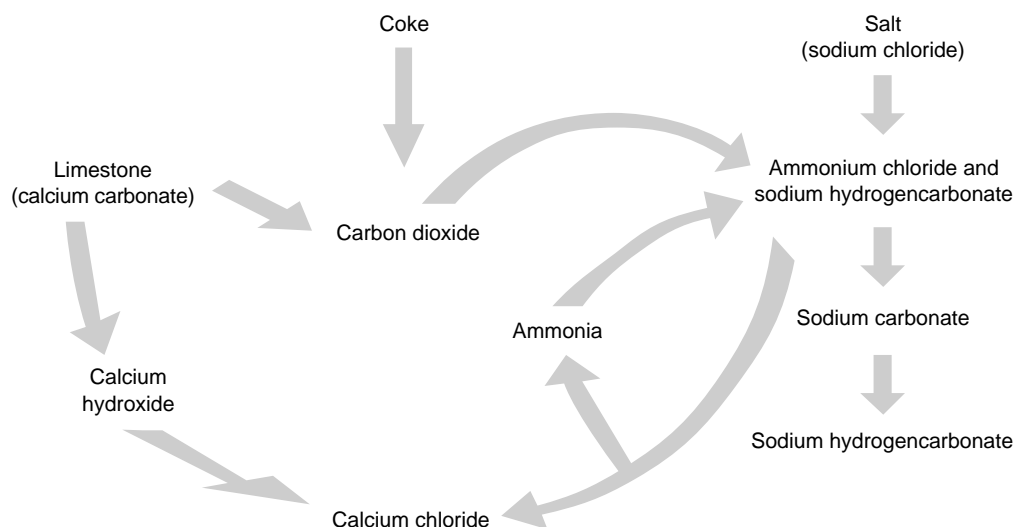


Fig 7

The flow chart in *Figure 7* shows an outline of the Solvay process. Look at the chart and try to answer the following questions.

Questions

5. Mark on a copy of the chart.
 - (a) The raw materials.
 - (b) The final products.
 - (c) Any intermediates (these are chemicals which take part in the process but which are neither raw materials nor products).

You could use different coloured pens or highlighters for each category.

6. Some of the reactions in the cycle are exothermic (they give out heat) and some are endothermic (heat must be put in to make them go). Use a red highlighter to mark any processes which you know are exothermic and a blue highlighter to mark any which you know are endothermic. Don't worry if you cannot do all the sections. Thinking back to the experiments you did in *The lime cycle* might help.
7. Suggest two uses for each of the products.
8. Which chemical appears both as a product and an intermediate?
9. Try to identify a re-usable intermediate.
10. Ammonium chloride was previously used in some types of batteries. If this type of battery became popular again, the demand for ammonium chloride would increase. What effect might this have on the overall production scheme?