28. Chemical filtration

Topic
Adsorption, separation.

Timing
45 min.

Description
Students observe how specially treated carbon removes colour and odour from various solutions.

Apparatus and equipment (per group)
- Funnel
- Test-tube
- Filter paper
- Test-tube rack.

Chemicals (per group)
- Potassium manganate(VII)
- Decolourising carbon (activated charcoal)
- Ink or food colouring
- Sauerkraut, dill pickle juice, or vinegar.

Teaching tips
1. Adsorption by charcoal is also used to remove unburned hydrocarbons from car exhausts, harmful gases from the air, and unwanted colours from certain products.
2. Students may find the difference between adsorption and absorption confusing. Adsorption: a gas, liquid, or a dissolved substance is gathered on the surface of another substance – eg charcoal. Absorption: a liquid is soaked up, as with a blotter. It is taken in completely and mixes with the absorbing material – eg absorbent cotton.
3. Carbon reduces the purple MnO$_4^-$ (Mn(VII)) ion in manganate(VII) to the colourless Mn$^{2+}$ (Mn(II)) ion.
4. Charcoal powder is very black and very messy.
5. Juice from sauerkraut, dill pickle or vinegar still smells after filtration, but noticeably less.

Background theory
Heating wood to a very high temperature in the absence of air makes charcoal. When it is heated to an even higher temperature, about 930 °C, impurities are driven from its surface and it becomes activated charcoal, sometimes called decolourising charcoal. This activated charcoal can remove impurities in either the gaseous or liquid state from many solutions. It does so by the process of adsorption, or by attracting these molecules to the surface.

Safety
Wear eye protection.
Answers

1. In each case the filtrate is colourless and clear and does not have the impurities in the original solution.

2. Charcoal has many small holes. This feature gives it a large surface area. This large surface area allows it to attract a large number of molecules of the impure substances.

3. Water is filtered through charcoal to remove impurities that would otherwise discolor and give a bad taste to drinking water.
Chemical filtration

Introduction

In this experiment, carbon that has undergone special treatment to make it into decolourising carbon is shown to remove colour and odour from various solutions. This form of carbon is sometimes called activated charcoal. This method is used to remove objectionable taste and odours from drinking water.

What to do

1. Fold a piece of filter paper, place it in a funnel, and put the stem of the funnel into a test-tube in a test-tube rack.
2. Add about five spatulas of decolourising carbon to the funnel
3. Add one drop of ink or food colour to 100 cm$^3$ of water in a beaker.
4. Carefully pour some of the coloured water onto the charcoal in the filter paper.
5. Prepare another filter paper with the same amount of carbon. This time filter a solution made by adding two or three crystals of potassium manganate(VII) to 100 cm$^3$ of water.
6. Repeat the activity, this time filter sauerkraut juice, dill pickle juice or vinegar.

Safety

Wear eye protection.

Questions

1. Describe the material before and after filtration in each of the three activities.
2. How does carbon remove colour and odour?
3. How could this process be used to provide pure water for drinking?