
Cracking hydrocarbons: a microscale version

A barrel of crude oil contains hydrocarbons of many different sizes. The exact composition of the crude oil varies depending on where it comes from, but most oil contains more of the larger molecules than the smaller ones. The smaller ones, however, are more useful and therefore more valuable. To increase the profit that can be made from a barrel of oil, the larger hydrocarbons are broken down into smaller ones. You are going to carry out a small scale version of this conversion, which is performed in industry every day.

What you need

- 2 comboplates®
- 1 x 10 cm³ syringe
- 1 x 10–15 cm piece straight glass tube
- 2 x L-shaped pieces of glass tube
- 4 x 1–2 cm length of silicone tubing
- 1 plastic pipette
- 1 microburner filled with ethanol
- 2 x lid number 2 for the comboplate® (with one long and one short port)
- Mineral wool
- Aluminium oxide
- Liquid paraffin – about 0.5 cm³
- Bromine water (less than 1%) – about 3 cm³ (**Harmful** and **Irritant**)
- Eye protection.



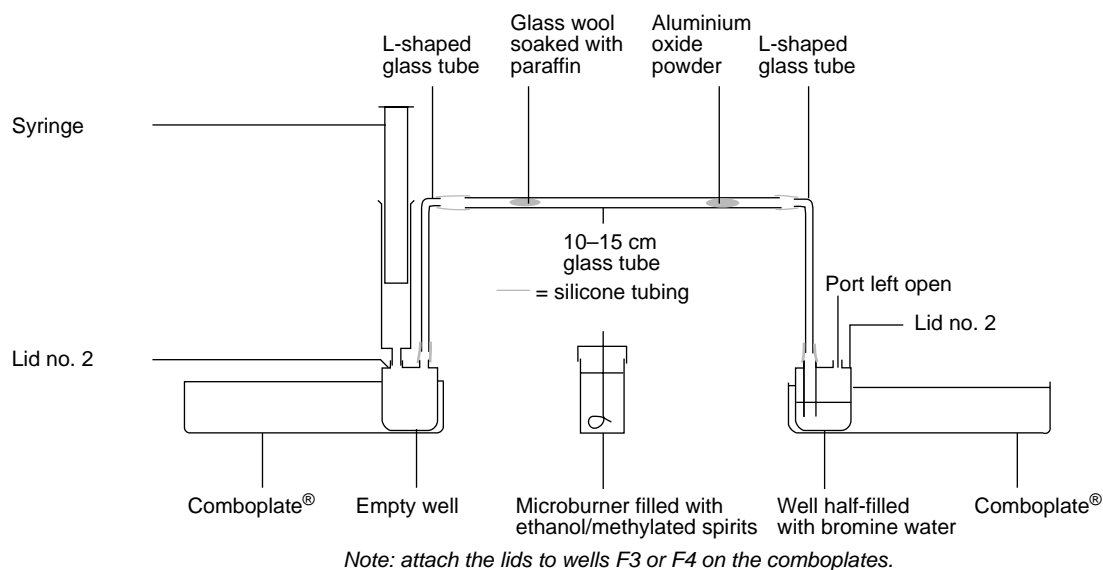
Health and safety

Wear eye protection at all times during this experiment, including during set-up and dismantling.

Ethanol is highly flammable. Always keep the microburner upright to prevent spills.

Bromine water is harmful and an irritant. Avoid contact with the skin and do not breathe in the fumes. If you get bromine on your hands, wash them straight away.

Diagram



Setting up

- Put on your eye protection.
- Pull the plunger of the syringe until it is fully extended. Fit the syringe to one of the lids. Attach the lid to well F3 on one of the comboplates[®]. The syringe and the well should be empty.
- Half fill well F3 on the other comboplate[®] with bromine water and attach the other lid.
- Attach a piece of silicone tubing to each end of the L-shaped glass tubes. Hold the glass tube near the end you are attaching to the silicone tubing to reduce the likelihood of breaking the glass and cutting yourself.
- Attach the long end of each L-shaped tube to the lids on the comboplates[®].
- Put some glass wool in one end of the straight glass tube. Push it at least 2 or 3 cm down the tube (a piece of wire or small stick helps). Add 5 or 6 drops of liquid paraffin to the glass wool using a pipette. About 0.5 cm of the tube should be filled with paraffin.
- Holding the tube as horizontal as possible so as not to lose your paraffin, put 1 microspatula of aluminium oxide in the other end.
- Attach the straight glass tube between the L-shaped tubes, making sure the paraffin is at the end with the syringe.
- Get your set-up checked by your teacher before you go any further.

Cracking the hydrocarbons

- Wear eye protection.
- Light your microburner, pick it up and begin to heat the aluminium oxide. Make sure the oxide is very hot before you go any further. As you heat, very slowly depress the plunger on the syringe. If at any stage the plunger gets to the bottom, remove the syringe, pull the plunger out, re-attach it and carry on pressing it down slowly.
- Begin to flick your microburner over the paraffin to heat that up too – make sure you keep heating the aluminium oxide enough to keep it hot. You can see when the paraffin is boiling. As it turns into a vapour it will pass through the glass wool and over the catalyst (the aluminium oxide).

- Watch what happens to the bromine water. When you see no more changes or you have run out of paraffin, stop heating.
- Put a few drops of paraffin in one of the other large wells in your plate and add a few drops of bromine water. Observe what happens.
- Wait until the apparatus has cooled before you dismantle it.

Questions

1. Make a copy of the table below and use it to record your observations.

Substance	Colour	State	What happened when it was mixed with bromine water?	Ease of catching fire (if done)
Starting material paraffin				
Product _____				

2. Did you observe anything else during the course of your experiment?

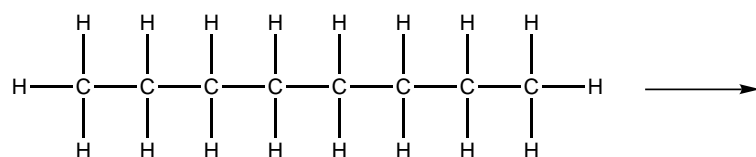
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3. The states of the reactant and product are different. What does this suggest about the sizes of their molecules?

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A molecular model kit may help you answer the next few questions. Make a model of each of the molecules. Remember that carbon must always form four bonds and hydrogen forms one.

4. Paraffin can be represented as shown below (although actually its molecules are bigger).



During cracking two of the carbon atoms break off. Work out what the products of the reaction are and complete the equation started above.

5. Paraffin is an alkane. One of the products is also an alkane and the other is an alkene. Decide which is which and label the substances in your equation as either alkanes or alkenes.

6. How could you use bromine water to find out if hydrocarbons were alkanes or alkenes?

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7. Make a model of bromine, Br–Br. Use two green atoms for the model. Work out what happens when bromine reacts with an alkene like ethene and draw an equation for the reaction.

8. Explain why alkanes do not react with bromine.

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