The cracking of petroleum (Item No.: P7171300)

Curricular Relevance

Area of Expertise: Chemie
Education Level: Klasse 7-10
Topic: Organische Chemie
Subtopic: Kohlenwasserstoffe und Petrochemie
Experiment: Cracken von Erdöl

Difficulty	Preparation Time	Execution Time	Recommended Group Size
Easy	10 Minutes	10 Minutes	2 Students

Additional Requirements:

Experiment Variations:

Keywords:

petrochemistry, petroleum, cracking of petroleum

Task and equipment

Information for teachers

Learning objectives

- Higher boiling alkanes can be split to lower boiling hydrocarbons by catalytic cracking.
- The products which result from this process are alkenes and alkanes.

Notes on setup and procedure

Preparation:
Prepare the bromine water directly before the experiment is performed (add a few drops of bromine to distilled water). Filling the bromine water into the side-arm test tube before the experiment is recommended, to avoid any student contact. Prepare the soda-alkaline potassium permanganate solution by putting a few small potassium permanganate crystals in 50 ml of water and adding a spoonful of sodium carbonate.

Remarks on the students experiments:
Ensure that the activated carbon is heated sufficiently. The liquid paraffin must only be added dropwise as otherwise the flask could crack because of the temperature difference. If a pearl catalyst is used instead of activated carbon, the heating can be less strong. The Bunsen burner must not be held at the side-arm outlet of the second test tube, as combustible gases may be emitted there!

Hazard and precautionary statements

Bromine:	
H330:	Fatal if inhaled.
H314:	Causes severe skin burns and eye damage.
H400:	Very toxic to aquatic life.
P210:	Keep away from heat/sparks/open flames/hot surfaces – No smoking.
P273:	Avoid release to the environment.
P304 + P340:	IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing.
P305 + P351 + P338:	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses if present and easy to do – continue rinsing.
P309 + P310:	IF exposed or you feel unwell: Immediately call a POISON CENTER or doctor/physician.
P403 + P233:	Store in a well ventilated place. Keep container tightly closed.
P501:	Dispose of contents/ containers to be collected by a licensed contractor in accordance with national and local regulations.
Potassium permanganate:	
H272:	May intensify fire; oxidizer.
H302:	Harmful if swallowed.
H410:	Very toxic to aquatic life with long lasting effects.
P210:	Keep away from heat/sparks/open flames/hot surfaces – No smoking.
P273:	Avoid release to the environment.
P501:	Dispose of contents/ containers to be collected by a licensed contractor in accordance with national and local regulations.
Sodium carbonate:	
H319:	Causes serious eye irritation.
P260:	Do not breathe dust.
P305 + P351 + P338:	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses if present and easy to do – continue rinsing.
P501:	Dispose of contents/ containers to be collected by a licensed contractor in accordance with national and local regulations.

Hazards

- Liquid paraffin is combustible. Extinguish all open flames when handling it!
- Potassium permanganate solution and bromine water are corrosive! Avoid contact with the skin! Immediately wash off splashes with plenty of water! Wear protective gloves and protective glasses!
- To make glass/rubber connections, wet the glass with glycerol so that it can be easily inserted!

Notes

The cracking process which occurs on the surface of the activated carbon is more complicated than shown by the equation above. Carbon and hydrogen are also formed. The catalysts which are nowadays used technically (Al/Si oxides) allow a good control of the reaction and even a specific choice of products. Branched and aromatic hydrocarbons can also be produced.

Remarks on the method

This experimentally quite ambitious test relates back to the "Characterization of ethylene" (P7171000), which must therefore be carried out prior to this experiment.

Waste disposal

Put the contents of all vessels into the container for combustible organic waste.

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Task and equipment

Task

How can higher boiling petroleum fractions be "refined"?

Produce lower boiling hydrocarbons from liquid paraffin.

Equipment

Position No.	Material	Order No.	Quantity
1	Support base, variable	02001-00	1
2	Support rod, stainless steel, l=370 mm, d=10 mm	02059-00	3
3	Spoon, special steel	33398-00	1
4	Dropping funnel with drip nozzle, 50ml	36912-00	1
5	Test tube,180x20 mm,side arm,PN19	36330-00	2
6	Rubber gloves, size S (7)	39325-00	1
7	Protecting glasses, clear glass	39316-00	1
8	Boss head	02043-00	3
9	Reaction flask, 100ml, PN19	34885-00	1
10	Test tube, 180x18 mm,100pcs	37658-10	(1)
11	Test tube brush w. wool tip,d25mm	38762-00	1
12	Universal clamp	37715-00	3
13	Rubber tubing, i.d. 6 mm	39282-00	1
14	Glass tubes,right-angled, 10	36701-59	(2)
15	Rubber stopper, d = 22/17 mm, 1 hole	39255-01	3
16	Glass beaker DURAN®, short, 250 ml	36013-00	1
	Butane burner f.cartridge 270+470	47536-00	1
	Butane catridge CV 300 Plus, 240 g	47538-01	1
	Activated carbon, granular 250 g	30011-25	1
	Bromine 100 ml	30046-10	1
	Glycerol, 250 ml	30084-25	1
	Potassium permanganate, chem. pur., 250 g	30108-25	1
	Sodium carbonate, anhyd. 1000 g	30154-70	1
	Liquid paraffin 1000 ml	30180-70	1
	Water, distilled 5 l	31246-81	1

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Set-up and procedure

Set-up

Hazards

- Liquid paraffin is combustible. Extinguish all open flames when handling it!
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- To make glass/rubber connections, wet the glass with glycerol so that it can be easily inserted!

Setup

Set up the stand as shown in Fig. 1 to 3.

Fig. 1

Fig. 2

Fig. 3

Fix the round-bottomed flask to the support rod on the left (Fig. 4). Carefully screw the two right-angled glass tubes (wet with glycerol) through the holes of the rubber stoppers (Fig. 5). Screw the outlet tube of the separating funnel to ease it through the hole of the rubber stopper so that the tip protrudes about 5 cm out of the stopper (Fig. 6).


Fig. 4

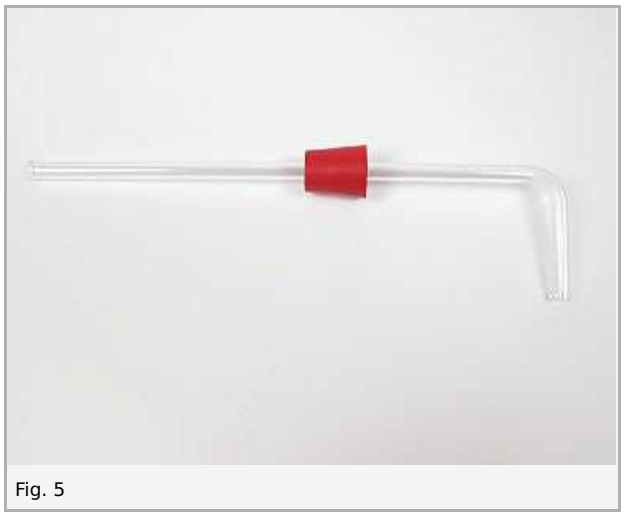
Fig. 5

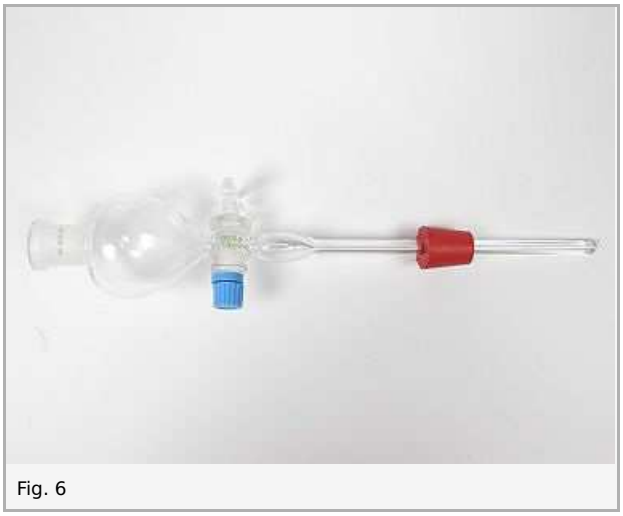
Fig. 6

Fix the first side-arm test tube at the center of the right support rod. Connect the side-arm of the first test tube to the right-angled glass tube in the stopper fitted on the second side-arm test tube. Put this second test tube in the beaker and fill the beaker with ice. Fix the second test tube to the right support rod. Fill the first side-arm test tube one third full with bromine water and put so much activated charcoal in the round-bottom flask that the bottom is well covered (Fig. 7).


Fig. 7

Connect the side-arm of the round-bottomed flask with the right-angled glass tube. Close the round-bottomed flask with the stopper holding the separating funnel (make sure that the tap is closed). Fill 5 ml of liquid paraffin into the separating funnel (Fig.

8+9).

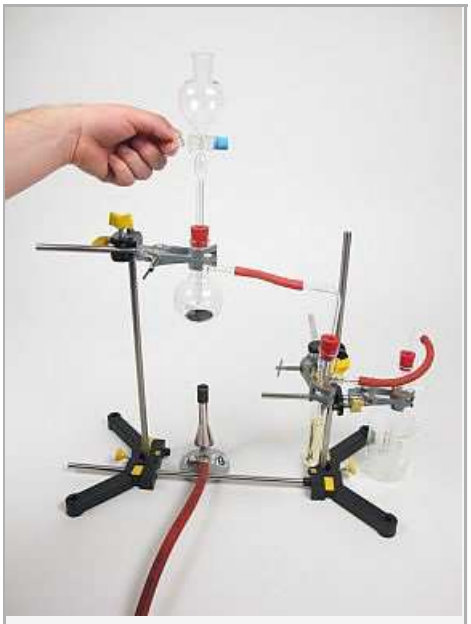

Fig. 8

Fig. 9

Procedure

Heat the activated carbon, carefully at first and then more strongly (Fig. 10). Slowly open the tap of the separating funnel so that just a few drops of liquid paraffin flow out, then let the liquid paraffin flow out dropwise for several minutes.

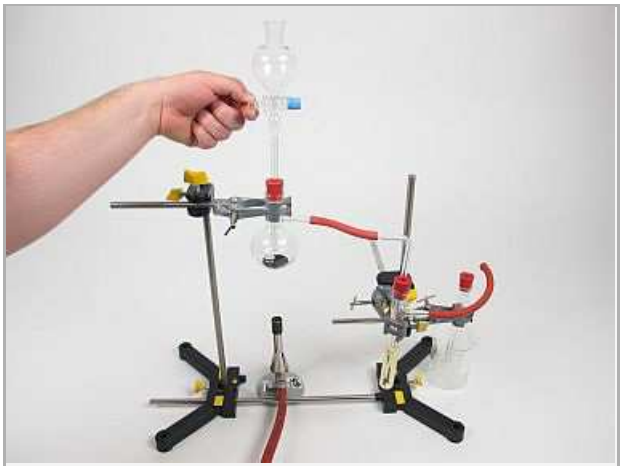

Fig. 10

When the bromine water has reacted completely, stop the heating and let the apparatus cool down. Remove the cooled side-arm test tube from the apparatus, take off the rubber stopper and add a few drops of soda-alkaline potassium permanganate solution to the condensate (Fig. 11).

Fig. 11

Carry out the same test with liquid paraffin in a test tube.

Waste disposal

- Put the contents of all vessels into the container for combustible organic waste.

Report: The cracking of petroleum

Result - Observations

Note the observations you make.

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Evaluation - Question 1

Draw conclusions from your observations.

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Evaluation - Question 2

Give examples of how the performed reaction is used on an industrial scale.

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Evaluation - Question 3

Formulate the appropriate equation for the process which took place (on the basis of a higher alkane).

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