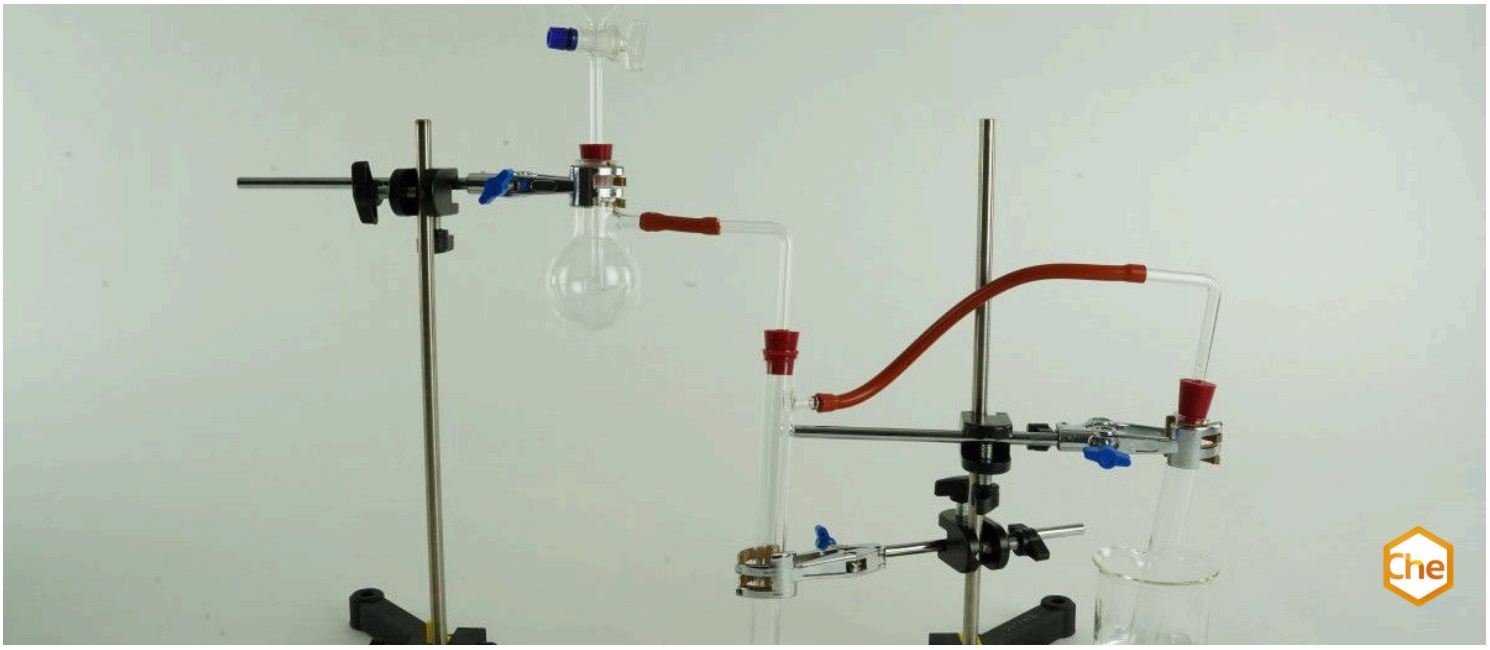
The cracking of liquid paraffin



Chemistry > Industrial Chemistry > Petrochemistry

Difficulty level	Group size	Preparation time	Execution time
easy	2	10 minutes	10 minutes

This content can also be found online at:

http://localhost:1337/c/638b6a558ff8b60003be7e2d

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Teacher information

Application

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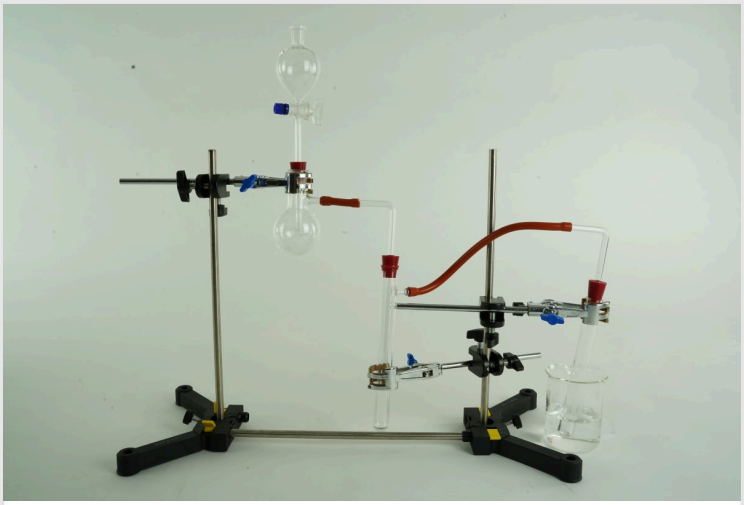

The experimental setup

Crude oil is a mixture of more than 500 different organic compounds.

Among them are many long-chain hydrocarbons, which are not as commercially in demand as short-chain hydrocarbons.

This is why the industry often uses oil cracking, the process by which long-chain alkanes are broken down into short-chain alkanes.

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Other teacher information (1/5)

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Prior knowledge

Students should already have basic knowledge about saturated and unsaturated hydrocarbons and the composition of petroleum.

Further, students should know the basics of working with chemicals and be able to work with a butane gas or Bunsen burner.

Principle

Paraffin oil is split by heat with the help of a catalyst into short-chain, mainly gaseous hydrocarbons. The proportion of unsaturated compounds increases greatly, which can subsequently be detected by the Baeyer reagent.

Other teacher information (2/5)

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Learning objective

The students should learn that higher-boiling alkanes can be decomposed into lower-boiling hydrocarbons by catalytic cracking. The products of this process are alkenes and alkanes.

Tasks

Produce low-boiling hydrocarbons from paraffin oil.

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Other teacher information (3/5)

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Note on preparation

Prepare soda alkaline potassium permanganate solution. To do this, add a few small potassium permanganate crystals to 50 ml of water, add a spoonful of sodium carbonate.

Unsaturated hydrocarbons can also be detected by bromine water. Due to its carcinogenic properties, the Baeyer reagent is recommended for student experiments.

Note on the theory

In this experiment, the long-chain hydrocarbons of paraffin oil are split to short-chain alkenes and unsaturated hydrocarbons. For example:

$$Energy + C_{23}H_{48}\ (l) \rightarrow 2\ C_3H_8\ (g) + 5\ C_3H_6\ (g) + C_2H_2\ (g)$$

Other teacher information (4/5)

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Notes on the student experiments

Make sure that the bead catalyst is heated sufficiently. The paraffin oil may only be added drop by drop, otherwise the flask may crack due to the temperature differences that occur. If you use catalysts other than the bead catalyst, for example steel wool or activated carbon, these alternatives must be heated much more.

The burner must not be held to the outlet of the second test tube with preparation nozzle, as flammable gases may escape from there!

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Other teacher information (5/5)

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Methodological remarks

The test, which is quite demanding in terms of experiment, draws on the "ethene representation" test for the detection methods, which may have to be preceded by this test.

Bunsen burners can still be used instead of butane burners for this experiment.

Disposal

Put the contents of all containers into the collection container for combustible organic substances.

Safety instructions

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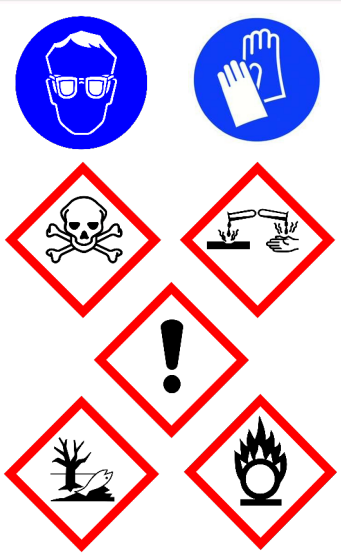

The general instructions for safe experimentation in science lessons apply to this experiment.

For H- and P-phrases please consult the safety data sheet of the respective chemical.

Dangers

- Paraffin oil is flammable. Extinguish all open flames during filling!
- Potassium permanganate solution is corrosive. Avoid contact with the skin! Wash off splashes immediately with plenty of water! Use protective gloves and wear safety goggles!
- Make rubber-glass compounds slippery with glycerine!

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Student information

Motivation

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A petrol pump

The industry's demand for short-chain alkanes is significantly greater than that for long-chain alkanes. This is mainly because short-chain alkanes are needed for a number of essential fuels such as petrol and diesel, while long-chain hydrocarbons are used almost exclusively as fuel oil.

For this reason, long-chain alkanes are often broken down into short-chain alkanes. This so-called "cracking" is examined in more detail in this experiment. Here, the process is supported by a catalyst (Al/Si oxides).

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Tasks

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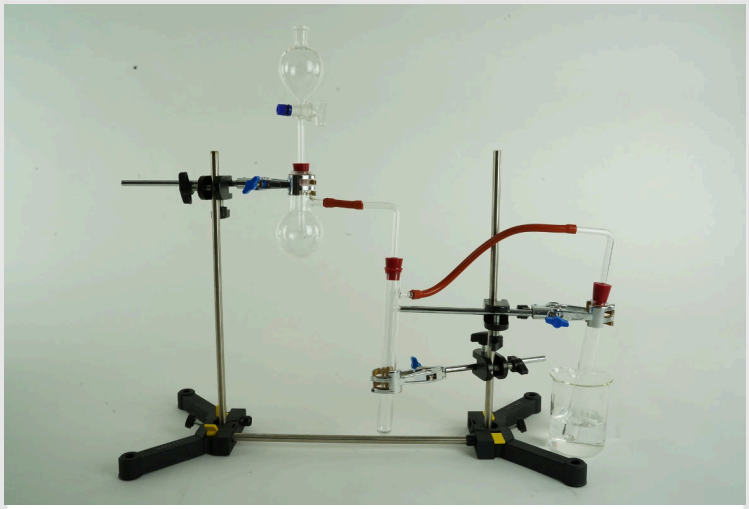

The experimental setup

How can higher-boiling petroleum fractions be "refined"?

Produce low-boiling hydrocarbons from paraffin oil.

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Equipment

Position	Material	Item No.	Quantity
1	Support base, variable	02001-00	1
2	Support rod, stainless steel, l=370 mm, d=10 mm	02059-00	3
3	Boss head	02043-00	3
4	Spoon, special steel	33398-00	1
5	Round bottom flask w. side arm, 100 ml, PN19	34885-00	1
6	Beaker, Borosilicate, low form, 250 ml	46054-00	1
7	Glass tubes,right-angled	MAU-10030701	1
8	Dropping funnel with drip nozzle, 50ml	36912-00	1
9	Test tube, 180x18 mm,100pcs	37658-10	1
10	Test tube,180x20 mm,side arm,PN19	MAU-17080301	2
11	Test tube brush w. wool tip,d20mm	38762-00	1
12	Universal clamp	37715-01	3
13	Rubber stopper, d = 22/17 mm, 1 hole	39255-01	3
14	Rubber tubing, i.d. 6 mm	39282-00	1
15	Protecting glasses, clear glass	39316-00	1
16	Rubber gloves, size M (8), one pair	39323-00	1
17		CHE-881317634	1
18	Glycerol, 250 ml	30084-25	1
19	Potassium permanganate, chem. pur., 250 g	30108-25	1
20	Sodium carbonate, anhyd. 1000 g	30154-70	1
21	Liquid paraffin 1000 ml	30180-70	1
22	Butane burner with cartridge, 220 g	32180-00	1
23	Water, distilled 5 l	31246-81	1

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Set-up (1/6)

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1. Set up the support according to Fig. 1 to 3.

Figure 1

Figure 2

Figure 3

Set-up (2/6)

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2. Clamp the round piston on the left stand rod (Fig. 4).

3. Screw the two angled glass tubes into the pierced rubber stoppers (Fig. 5).

Figure 4

Figure 5

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Set-up (3/6)

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4. Carefully turn the outlet of the separating funnel as far as it will go into the pierced rubber plug SB 19 (**Attention:** Always lubricate the rubber stopper with glycerine) so that the spout protrudes approx. 5 cm through the rubber stopper (Fig. 6).

Figure 6

Set-up (4/6)

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5. Fill the round bottom flask with the bead catalyst until the bottom is well covered (Fig. 7).

6. Close the test tube with the attachment nozzle with the rubber stopper of the angled glass tube (Fig. 8).

7. Connect the neck of the round-bottomed flask to the short leg of one of the angled glass tubes using a piece of tubing and insert them into the test tube.

Figure 7

Figure 8

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Set-up (5/6)

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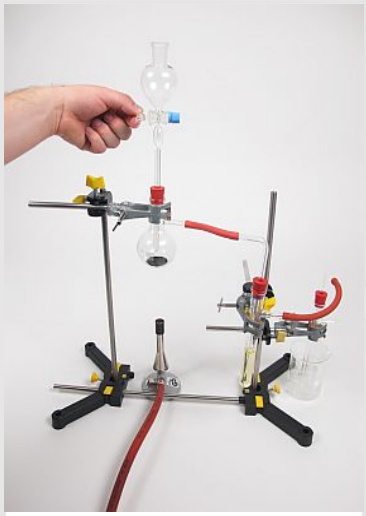

Figure 9

8. Close the round-bottomed flask with the rubber stopper on the separating funnel and fill the separating funnel with approx. 5 ml paraffin oil with the tap closed (Fig. 9 and 10).

Figure 10

Set-up (6/6)

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9. Connect the neck of the first test tube to the angled glass tube of the second test tube with neck using a piece of tubing.

10. Place the second test tube with the preparation spout in the beaker and fill it with ice (Fig. 11).

11. Attach the test tube with the attachment nozzle to the second stand rod (Fig. 12).

Figure 11

Figure 12

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Procedure (1/2)

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Figure 13

1. Heat the bead catalyst.

2. Slowly open the tap of the separating funnel so that only a few drops of paraffin oil flow out.

3. Then let the paraffin oil flow in drop by drop over several minutes (Fig. 13).

Procedure (2/2)

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Figure 14

4. Finish the experiment and let the apparatus cool down.

5. Detach the second test tube with the preparation nozzle from the apparatus, remove the rubber stopper and add a few drops of soda-alkaline potassium permanganate solution to the condensate (Fig. 14).

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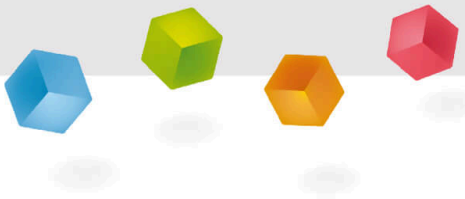

Report

Task 1

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Write down your observations.

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Task 2

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Fuels

short-chain alkanes	long-chain alkanes

Petrol | Fuel oil (heavy) | Diesel | Marine fuel

Check

Task 3

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Drag the words into the correct boxes!

Long-chain _____ can be broken down into more commercially valuable, short-chain alkanes and _____ by catalytic _____.
This process usually takes place at very high _____. Catalytic cracking also uses a _____ that breaks down the long-chain hydrocarbons into short-chain alkanes and alkenes over many reactions.

hydrocarbons | catalyst | alkenes | temperatures | cracking

Check

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Task 4

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Drag the words into the correct boxes!

In catalytic cracking, _____ are used to bring about a series of complicated reactions.
The _____ of the intermediate steps are usually very reactive and either decompose spontaneously or react further with other intermediates. _____ such as aluminium oxides and silicates are mainly used.

products
catalysts
Aluminium compounds

Check

Slide	Score / Total
Slide 23: Fuels	0/4
Slide 24: Catalytic cracking	0/5
Slide 25: Cracking catalysts	0/3

Total 0 / 12

Solutions Repeat Export text

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