Fractional distillation with the bubble tray column with Cobra4 (Item No.: P3031660)

Curricular Relevance

Area of Expertise: Chemistry

Education Level: University

Topic: Industrial Chemistry

Subtopic: Petrochemistry

Experiment: Fractional distillation with the bubble tray column with Cobra4

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

Additional Requirements:

- PC with USB interface, Windows XP or higher
- Soap solution
- Drying oven
- Precision balance, 620 g / 0.001 g

Experiment Variations:

Keywords:

bubble tray column, rectification, continuous and discontinuous distillation, vapour pressure, vaporisation, condensation, Raoult’s law, gas chromatography

Overview

Short description

Principle

In countercurrent distillation (rectification) using a column, the rising vapour can enter into interactions with the condensate. In this manner, a fractional distillation, i.e. a distillation in several steps for the separation of substances with similar boiling points, can be performed in a single apparatus. If bubble tray columns are used condensate can be removed from the individual bubble trays.

Chromatographic procedures allow a separation of substance mixtures with the aid of a stationary separating phase and a mobile phase. In gas chromatography the mobile phase is a gas. The establishment of equilibria between the stationary phase and the different substances (distribution equilibria, adsorption- desorption equilibria) results in different migration rates of the individual components. At the end of the column there is a detector in the form of a thermal conductivity cell, which can detect the different substances on the basis of their differing thermal conductivities.

Fig. 1: Experimental set-up for the fractional distillation with a bubble tray column.

Safety instructions

When handling chemicals, you should wear suitable protective gloves, safety goggles, and suitable clothing. Please refer to the appendix for detailed safety instructions.

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***n*-Pentane**
H225: Highly flammable liquid and vapour.
H304: May be fatal if swallowed and enters airways.
H336: May cause drowsiness or dizziness.
H411: Toxic to aquatic life with long lasting effects.
P273: Avoid release to the environment.
P301 + 310: IF SWALLOWED: Immediately call a POISON CENTER or doctor/physician.
P331: Do NOT induce vomiting.
P403 + 235: Store in a well ventilated place. Keep cool.

n-Hexane
H225: Highly flammable liquid and vapour.
H361: Causes mild skin irritation.
H304: May be fatal if swallowed and enters airways.
H373: May cause damage to organs through prolonged or repeated exposure.
H315: Causes skin irritation.
H336: May cause drowsiness or dizziness.
H411: Toxic to aquatic life with long lasting effects.
P210: Keep away from heat/sparks/open flames/hot surfaces – No smoking
P240: Ground/bond container and receiving equipment.
P273: Avoid release to the environment.
P301 + 310: IF SWALLOWED: Immediately call a POISON CENTER or doctor/physician.
P331: Do NOT induce vomiting.
P302 + 352: IF ON SKIN: Wash with soap and water.
P403 + 235: Store in a well ventilated place. Keep cool.

***n*-Heptane**
H210: Highly flammable liquid and vapour.
H304: May be fatal if swallowed and enters airways.
H315: Causes skin irritation.
H336: May cause drowsiness or dizziness.
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.
P302 + 310: IF SWALLOWED: Immediately call a POISON CENTER or doctor/physician.
P331: Do NOT induce vomiting.
P302 + 352: IF ON SKIN: Wash with soap and water.
P403 + 235: Store in a well ventilated place. Keep cool.

Equipment

Position No.	Material	Order No.	Quantity
1	Cobra4 Wireless/USB-Link incl. USB cable	12601-10	2
2	USB charger for Cobra4 Mobile-Link 2 and Wireless/USB-Link	07932-99	2
3	curricuLAB measureLAB	14580-61	1
4	Cobra4 Sensor-Unit 2 x Temperature, NiCr-Ni	12641-00	2
5	Cobra4 Sensor-Unit Chemistry	12630-00	1
6	Holder for Cobra4 with support rod	12680-00	3
7	Immersion probe NiCr-Ni, teflon, 300 °C	13615-05	4
8	Heating mantle f. roundbottom flask, 250ml	49542-93	1
9	Clamp for heating mantle	49557-01	1
10	Power regulator, 230 V, with phase controlled modulator	32286-93	1

11	Support base DEMO	02007-55	2
12	Support rod, stainless steel, 1000 mm	02034-00	2
13	Support rod, stainless steel, 750 mm	02033-00	4
14	Support rod, stainless steel, l = 250 mm, d = 10 mm	02031-00	1
15	Retort stand, h = 750 mm	37694-00	1
16	Right angle boss-head clamp	37697-00	14
17	Universal clamp	37715-00	12
18	Bubble tray column, model, with 2 trays	35914-15	1
19	Round bottom flask, 250 ml, 2-neck, GL25/12, GL18/8	35843-15	1
20	Connecting tube,IGJ 19/26-GL25/12	35800-05	1
21	Column head, with stopcock, ST 19/26	35919-01	1
22	Condenser,Dimroth,IGJ19/26,210mm	35816-05	1
23	Glass tubes,l.250 mm, pkg.of 10	36701-68	1
24	Cooling jacket, GL 25/8	34880-01	1
25	Separating funnel,50ml,GL18	35853-15	1
26	Connecting caps,10 pcs, GL18	41230-03	1
27	Gasket for GL18, 8mm hole, 10 pcs	41240-03	1
28	Teflon sleeve IGJ 19, 10 pcs	43616-00	1
29	Clamp f.ground joint,plastic,NS19	43614-00	2
30	Control unit gas chromatograph	36670-99	1
31	Mesure probe for gas chromatograph, BNC contact	36670-10	1
32	Glass jacket	02615-00	1
33	Gas separation column	36670-00	1
34	Glass tube, straight, l=80 mm, 10/pkg.	36701-65	1
35	Soap bubble flow meter	36675-00	1
36	Rubber caps, pack of 20	02615-03	1
37	Lab thermometer,-10..+100 °C	38056-00	1
38	Stopwatch, digital, 1/100 s	03071-01	1
39	Microliter syringe, 10 micro-l	02607-00	1
40	Syringe 1ml, Luer, 10 pcs	02593-03	1
41	Cannula 0,45x13 mm, Luer, 20 pcs	02598-04	1
42	Connecting cord, 32 A, 250 mm, red	07360-01	1
43	Connecting cord, 32 A, 250 mm, blue	07360-04	1
44	Immersion thermostat Alpha A, 230 V	08493-93	1
45	External circulation set for thermostat Alpha A	08493-02	1
46	Bath for thermostat, makrolon	08487-02	1
47	Rubber tubing, i.d. 6 mm	39282-00	10
48	Rubber tubing,vacuum,i.d.6mm	39286-00	2
49	Hose clip f.12-20 diameter tube	40995-00	4
50	Hose clip, diam. 8-16 mm, 1 pc.	40996-02	10
51	Steel cylinder helium, 2 l, filled	41776-00	1
52	Table stand for 2 l steel cylinders	41774-00	1
53	Reducing valve for CO2 / He	33481-00	1
54	Wrench for steel cylinders	40322-00	1
55	Round-bott.flask, 500ml,IGJ 29/32	35862-00	1
56	Connecting tube,IGJ29/32-GL18/8	35678-02	1
57	Teflon sleeve IGJ 29, 10 pcs	43617-00	1
58	Stopper,IGJ 29/32,glass,clear	41256-10	1
59	Dish, plastic, 150x150x65 mm	33928-00	1
60	Water jet pump, plastic	02728-00	1
61	Security bottle with manometer and three-way stopcock	34170-88	1
62	Spoon, special steel	33398-00	1
63	Funnel, glass, top dia. 55 mm	34457-00	1
64	Graduated cylinder 100 ml	36629-00	1
65	Pasteur pipettes, 250 pcs	36590-00	1

66	Rubber caps, 10 pcs	39275-03	1
67	Snap-cap vials,d=24mm,h=52mm,10p.	33621-03	2
68	Beaker, high, BORO 3.3, 150 ml	46032-00	2
69	Beaker, high, BORO 3.3, 250 ml	46027-00	1
70	Glass rod,boro 3.3,l=200mm, d=5mm	40485-03	1
71	Laboratory pen, waterproof, black	38711-00	1
72	Quartz glass wool 10 g	31773-03	1
73	Chromosorb, PAW, 80/100 Mesh, 20 g	31514-04	1
74	Boiling beads, 200 g	36937-20	1
75	Silicon grease Molykote, 50 g	31863-05	1
76	n-pentane 250 ml	31707-25	1
77	n-hexane,puriss. 100 ml	31369-10	1
78	n-heptane, extra pure 250 ml	31366-25	1
79	Acetone, chemical pure, 250 ml	30004-25	1
80	Dinonyl phthalate, 100 ml	31276-10	1
81	Water, distilled 5 l	31246-81	2
82	Ethyl acetate 250 ml	30075-25	1
83	Ethyl alcohol, absolute 500 ml	30008-50	1
84	Tubing connector, ID 6-10mm	47516-01	2
85	Gas bar	40466-00	2

Tasks

Setup and procedure

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1. Distillation

- Perform the experimental set-up according to Fig. 1.
- Pour 70 ml each of *n*-pentane, *n*-hexane and *n*-heptane into the 250 ml beaker and mix these hydrocarbons well by means of a stirring rod.
- Pipette a 1-to-2-ml sample of this mixture into a snap-lid vial for subsequent gas chromatographic analysis.
- Use a funnel to transfer the rest of the mixture to the 250 ml flask and add a number of boiling beads.
- Connect the four temperature probes to the Cobra4 Sensor Units 2 xTemperature. The temperature probe, which is placed in the ”sump”, should be connected to the channel ”T1” socket of one of the Cobra4 Sensor Units. The probe in the first tray of the column should be connected to the ”T2” socket of the same Sensor Unit. The probe in the second tray shoud be connected to the “T1” socket of the second Cobra4 Sensor Unit and the probe on top of the column should be connected to the “T2” socket of this Cobra4 Sensor Unit.
- Combine the Cobra4 Sensor Units 2 x Temperature with the Cobra4 Wireless-Links.
- Attach them to the retort stand with the holders for Cobra4 using right angle clamps.
- Start the PC and connect the Cobra4 Wireless Manager with a USB socket of the computer.
- After the Cobra4 Wireless-Links have been switched on, the sensors are automatically recognized. Some ID numbers (01 and 02) are allocated to the sensors. These numbers are indicated in the displays of the Cobra4 Wireless-Links.
- Call up the “measure” programme.
- Boot the experiment “Fractional distillation with the bubble tray column with Cobra4” (experiment > open experiment). The measurement parameters for this experiment are loaded now.
- Turn on the cooling and heat the ”sump” with the heating mantle.
- Adjust the heating power with the power regulator in such a manner that the mixture boils uniformly (set the regulator to approximately setting 7 to 8).
- Monitor the temperature in the ”sump”, in the two trays and in the head of the column on the screen of the PC.
- When the mixture is boiling and the temperatures of the two trays and in the column head are constant wait at least

another 30 minutes to reach the thermal equilibrium for total reflux (the stopcock of the column head is closed).

- Start the measurement with

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- Then take in each case a sample from the liquids which are collected in the column head and the two trays of the bubble tray column for subsequent gas chromatographic analysis. To do this open the stopcock of the column head and the stopcock of the dropping funnel and let the liquid rinse into a snap-lid vial.
- The stopcock of the dropping funnel is immediately closed but the stopcock of the column head should remain open (no reflux).
- The snap-lid vials should always be marked for a correct identification of the samples.
- Because of the opening of the stopcock of the column head the mixtures are boiling without any reflux. The result is an increasing of the boiling points in the two trays and the sump (see Fig. 2).

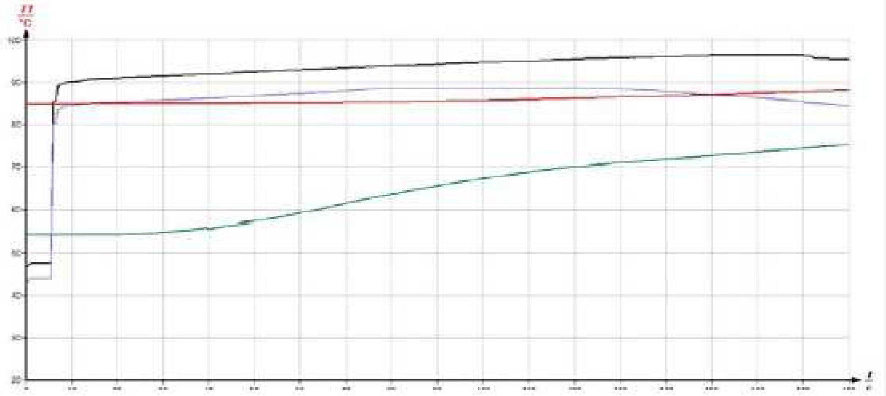

Fig. 2: Change of the boiling points without reflux (“sump”: red line; tray 1: black line;tray 2: blue line; column head: green line).

- Every time when 30 ml of vapour have condensed in the dropping funnel this volume and also the whole content of the two trays of the column are transferred into snap-lid vials.
- These samples are marked and stored for subsequent gas chromatographic analysis.
- At the end of the process nearly all of the mixture is collected in the snap-lid vials and only a very small volume of the liquid remains in the sump.
- Stop the measurement by pressing

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- The heater is turned off.
- After the apparatus has cooled down, additionally take one sample from the sump.

2. Gas chromatographic separation of the mixtures.

- Perform the experimental set-up according to Figs. 3 and 4.

Fig. 3: Experimental set up for the gas chromatograph.

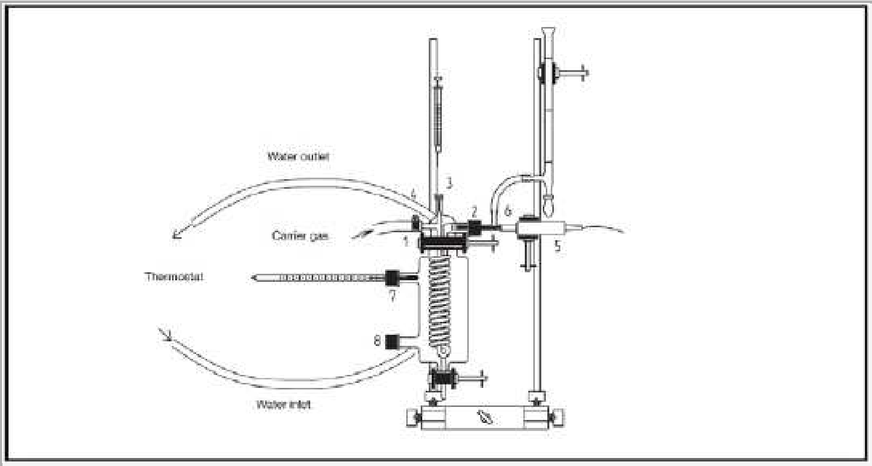

Fig. 4: Setup of the gas chromatograph.

- Prepare the stationary phase for the gas separating column by pouring acetone onto 10 g of Chromosorb in a round bottom flask until a thin film of liquid overlays the Chomosorb. Add a solution of 1.11 g of dinonylphthalate in about 10 ml of acetone and shake the mixture vigorously for several minutes. Place the flask in a dish containing warm water and use a water jet pump to reduce the pressure in the flask so much, that the acetone starts to boil gently.
- To recover the acetone, insert a security flask between the round bottom flask and the water jet pump. During the evaporation of acetone, frequently shake the round bottom flask. When the acetone has evaporated, empty the acetone collected in the security flask into the waste container for combustible organic material. Use the water jet pump to exert suction on the round bottom flask, held at about 70°C (water bath), for about another 2 hours. Subsequently it is important that the separating medium for the gas chromatographic column is completely dry and contains no remaining traces of solvent. If necessary, dry it further in a drying oven at about 100°C. Fill the prepared separating medium into the separating column using a funnel and a water jet pump. To do this, use a thin rod to push a quartz glass wool plug in the separating column connector through which the carrier gas used as mobile phase will later flow into the column (8 mm glass nipple), until it is at the start of the separating column, and push it a little so that it is quite firmly positioned. Following this, connect the glass nipple to the water jet pump and suck air through the column. Now hold the column with one hand and slant it so that a funnel can be held in the GL 18 threaded glass connector. Fill the prepared stationary phase in portions into this funnel, from which it will be immediately sucked into the column by the flow of air. It is recommended that the filling of the stationary phase is supported by slight, careful tapping on the glass tube with the free hand. It must be ensured, that the column is evenly filled. When the column has been filled, close the end through which the stationary phase has been filled in with a quartz glass wool plug, as previously done for the other end. Do not press the two plugs in too firmly, however, otherwise their resistance to the flow of carrier gas will be too high when the column is later put into operation. On the other hand, they must be firm enough to prevent carrier gas from pressurizing stationary phase out of the column.
- To set up the gas chromatograph fit the gas separation column into the glass jacket and mount this combination with two clamps vertically on the left support rod (cf. Fig. 2). Then connect a circulating thermostat, which is in a plastic vessel with a volume of about 6 litres (bath for thermostat), to the glass jacket via a rubber tubing so that the water input passes through a glass tube fitted to the lower tubular glass sleeve [8] into the glass jacket. The outflow occurs via the hose connection tube (hose olive) [4] at the rounded head of the separation column.
- Fit a thermometer into the upper tubular glass sleeve of the glass jacket [7] as an additional temperature control. Before

the set-up is further assembled, it is appropriate to turn on the water circulation (from the thermostat to the gas chromatograph and back) to test the system and concurrently to fill the glass jacket and the rounded glass head with water (bubble-free). While doing so, check for leaks in the water circulation system and if necessary eliminate them. If this partial setup functions properly, set-up the remainder of the experimental apparatus in the following sequence.

- Connect the pressure tubing (vacuum tubing) coming from the gas source (helium cylinder) to the glass hose connection (hose olive) [1]. Since this is under pressure throughout the experiment, secure it on both ends with hose clips. Fit the measuring probe [5] (sealing ring: GL 18/8 mm) into the connecting cap on the tubular glass sleeve [2] and secure it with a clamp.
- Connect the measuring probe via the lateral tubular glass sleeve [6] and a piece of rubber tubing with a soap bubble flow meter, in which 1 to 2 ml of soap solution has been poured. It is possible to occasionally add a small amount of soap solution to the gas flow via the rubber cap during the experiment. The gas bubble created in this way makes it possible to observe and measure the flow rate.
- Connect the measuring probe to the control unit for the gas chromatograph, which serves both to provide power and to calibrate the measuring probe, with its coaxial cable.
- *Take care!* Only switch on the control unit when the carrier gas is flowing, to avoid damage to the measurement probe from overheating!
- Combine the Cobra4 Sensor Unit Chemistry and with the Cobra4 Wireless-Link.
- Attach them to the retort stand with the holders for Cobra4 and right angle clamps.
- Connect the Cobra4 Sensor Unit Chemistry to the output socket of the control unit using two connecting cables and the adapter.
- Fit a rubber cap onto the injection port of the glass separating column as septum. Switch on the thermostat with circulating pump. Room temperature is sufficient for the separation of gases, but higher temperatures are generally required for the separation of liquid mixtures.
- When the required temperature has been attained, allow carrier gas (helium) to flow slowly through the separating column. Adjust the flow rate with the pressure reducing valve on the helium cylinder (while continually measuring with the soap bubble flow meter) to about 30 ml gas per minute. Make measurements with the flow rate with the soap bubble flow meter, attached as in Fig. 1, as follows: Repeatedly press the rubber cap with the 2 ml of soap solution to position some soap bubbles in front of the side glass nozzle. The entering flow of gas carries the bubbles up the tube. Measure the time taken for such a bubble to pass from the 0 ml mark to the 5 ml or 10 ml mark with a stopwatch. Calculate the flow rate per minute from this value. For example, when a soap bubble reaches the 10 ml mark in 15 seconds, then the gas flow in the gas separating column is 40 ml per minute.
- Start the PC and connect the Cobra4 Wireless Manager with a USB socket of the computer.
- After the Cobra4 Wireless-Link has been switched on, the sensor is automatically recognized. An ID number (01) is allocated to the sensor, which is indicated in the display of the Cobra4 Wireless-Link.
- Call up the “measure” programme.
- Boot the experiment “Chromatographic separations procedures: gas chromatography with Cobra4” (experiment > open experiment). The measurement parameters for this experiment are loaded now.
- The separation of a mixture of the three n-alkanes is carried out at 80 °C.
- Switch on the circulating thermostat.
- Set the thermostat to a temperature of 80°C and wait until the thermometer in the glass jacket shows a constant temperature of 80°C.
- Switch on the control unit some minutes before starting measurement (remember, only switch the control unit on when the carrier gas is flowing, to avoid damage to the measurement probe from overheating!).
- Press the coarse balancing button on the control unit, wait a few moments, then adjust the fine balancing rotary knob so that the value measured for the base line is approximately at 0 V.
- After three minutes, check the display. If the measured values have changed a lot, again press the coarse balancing button (but first turn the fine balancing rotary knob back to the middle position!)
- Use the valve of the helium cylinder and the soap bubble flow meter (with cap containing 1 to 2 ml of detergent solution) to adjust a flow rate of about 30 ml helium/min (10 ml/20 sec). Press the cap as above to appropriately produce and position bubbles.
- Draw 10 µl of each mixture, bubble-free, into the 10 µl microliter syringe. Start data collection with the PC by pressing

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  then carefully insert the cannulla of the syringe deeply through the septum, using the free hand to guide it, and quickly press the plunger.
- Draw the syringe rapidly out of the rubber cap (but take care, the cannulla can easily snap).
- Stop the measurement by pressing

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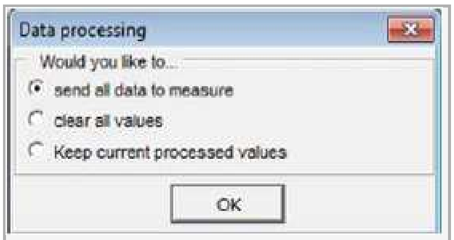
- After each measurement, send all data to “measure” (see Fig. 5) and save the data (File > Save measurement as).



Data processing

Would you like to...

● send all data to measure

○ clear all values

○ Keep current processed values

Fig. 5: Window which appears after measurement.

- Analyse all collected samples of the *n*-alkanes as described.
- Change the rubber cap used as septum after a few injections, as it will leak after several of them. Stop the flow of gas before changing it.

Theory and evaluation

The separation of hydrocarbon mixtures is a fundamental procdure of the petrochemical industry. The more widely separated the boiling points, the better the success of the separation. The separation effect can be improved if further distillations, in which the condensate of the respective previous distillation is again vaporised and condensed, follow the first stage of distillation (vaporisation - condensation). This process is performed continuously in industry and in the laboratory in fractionating columns. These columns can be realised as bubble tray or packed distillation columns. Bubble tray columns allow the continuous removal of condensate from arbitrary separation steps; packed columns are less complex and thus less expensive.

The gas chromatographic separation of a mixture of *n*-pentane, *n*-hexane and *n*-heptane (1:1:1 by volume) supplies, as expected, a chromatogram with three peaks (cf. Fig. 6). As we are dealing here with three compounds from a homologous series, so they must be eluted from the column in the succession of increasing numbers of carbon atoms. Thus, in figure 6 peak 1 can be assigned to *n*-pentane, peak 2 to *n*-hexane and peak 3 to *n*-heptane. This can be simply demonstrated by successively and separately adding a small amount of one of the pure substances to the mixture and observing the differences in the resulting chromatograms. The assignment of the substances to the peaks can also be derived from the retention times of the pure substances. If the sample is injected with a small amount of air, one occasionally obtains a small air peak first.

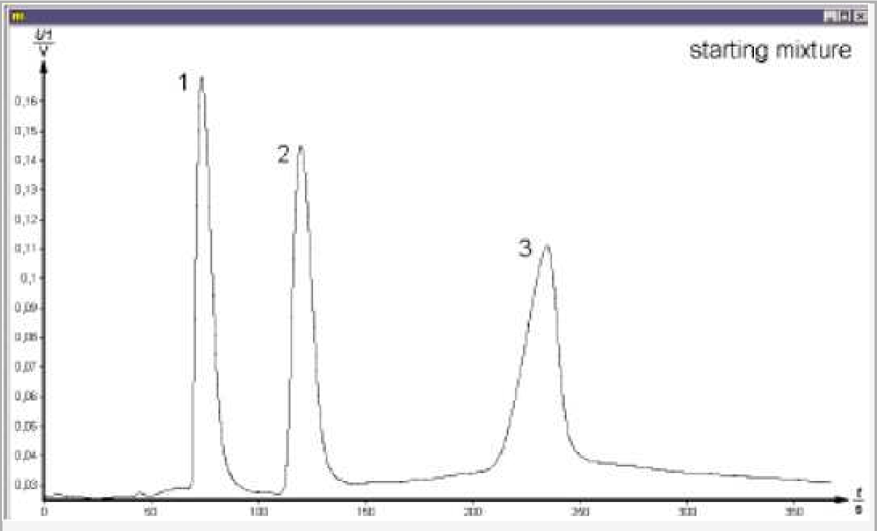


Fig. 6: Gas chromatographic separation of the starting mixture (1:1:1).

The chromatograms of the samples which are taken during the distillation show that the compositions of this samples are different (cf. Figs. 7 – 9).

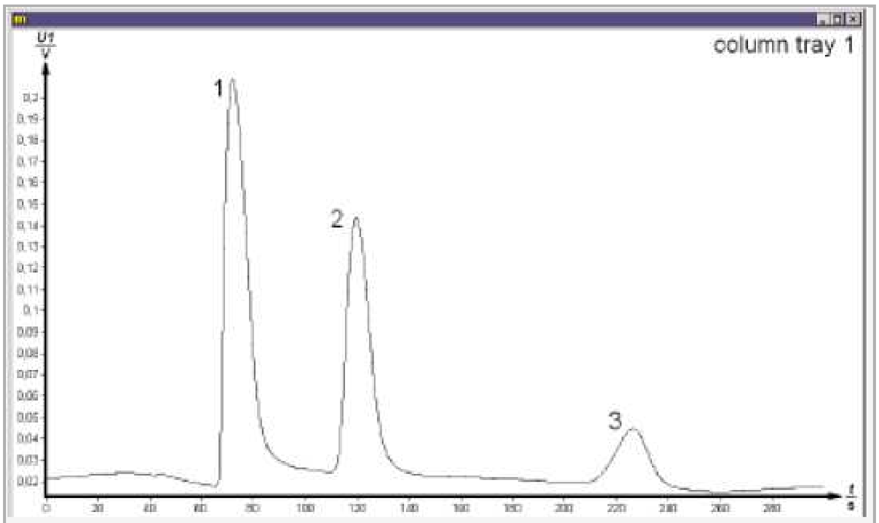


Fig. 7: Gas chromatographic separation of the mixture from the tray 1 (total reflux).

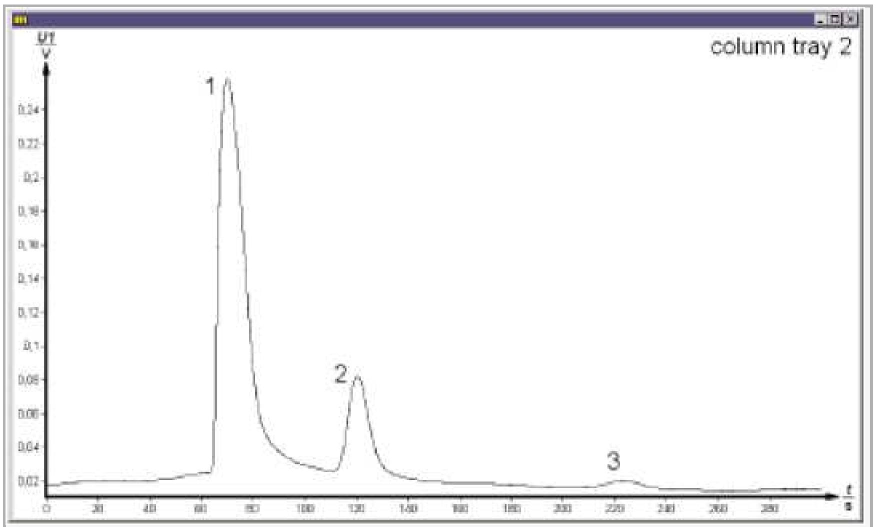


Fig. 8: Gas chromatographic separation of the mixture from the tray 2 (total reflux).

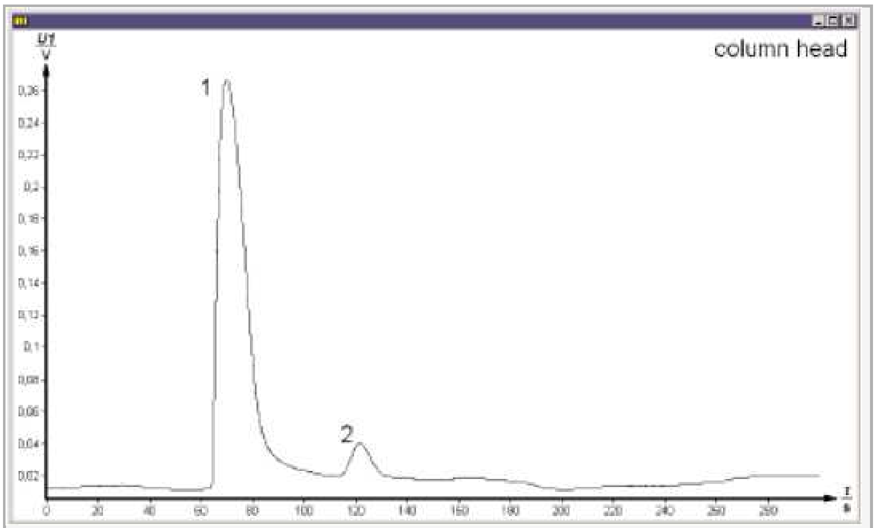


Fig. 9: Gas chromatographic separation of the mixture from the column head.

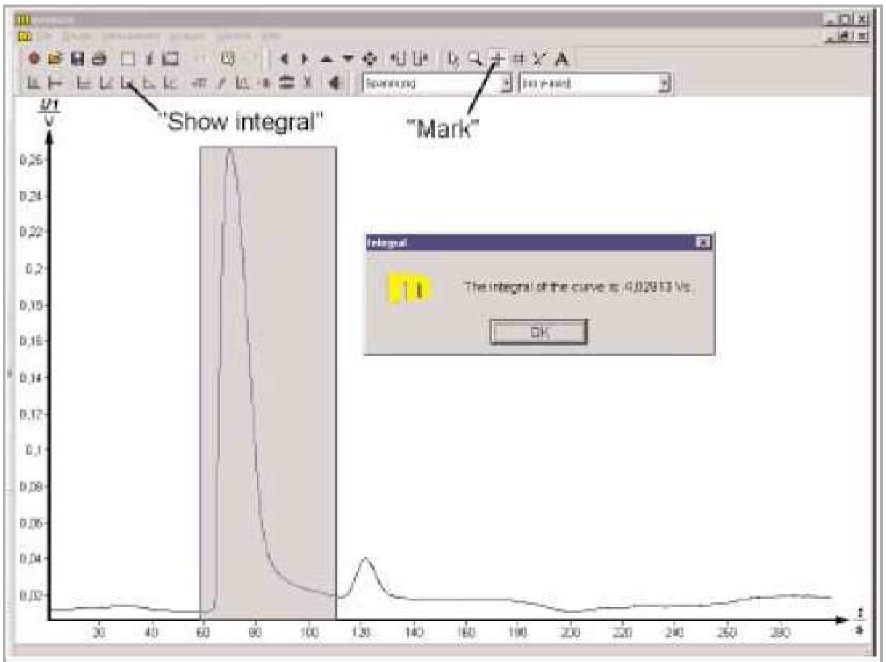
The chromatographic separations of the mixtures of the three alkanes were carried out under the following conditions:

Column temperature: 75°C

Carrier gas flow rate: 30 ml/min, helium

Total amount injected: 5 µl liquid mixture

A direct quantitative comparison of the gas chromatograms with one another is problematical. For this reason, the peak areas (integrals) of the individual peaks are determined as follows: First choose the option ”Mark” and mark the peak by means of the mouse. Then activate the funcition ”Show integral” (see Fig. 10). The value of the integral is now announced in the appearing window.



The integral of the curve is: 0,02913 Vs

Fig. 10: Determination of an integral.

After all peak areas of one chromatogram are determined this way they are added up. This is the integral for the whole chromatogram (= 100%). From this the percental fractions of the individual peaks are determined by dividing the integrals of the individual peaks by this sum of all integrals. To make a more simple comparison, the composition of the samples can then be presented, e.g., in the form of a histogram (see Fig. 11-14).

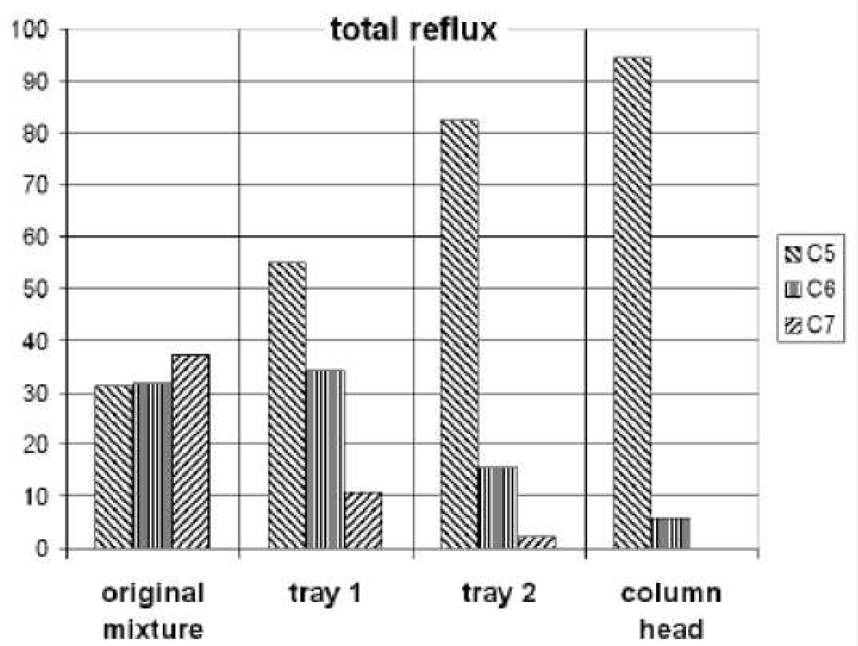


Fig. 11: Comparison of the percental peak area fractions of the hydrocarbons before(original mixture) distillation and during distillation with total reflux.

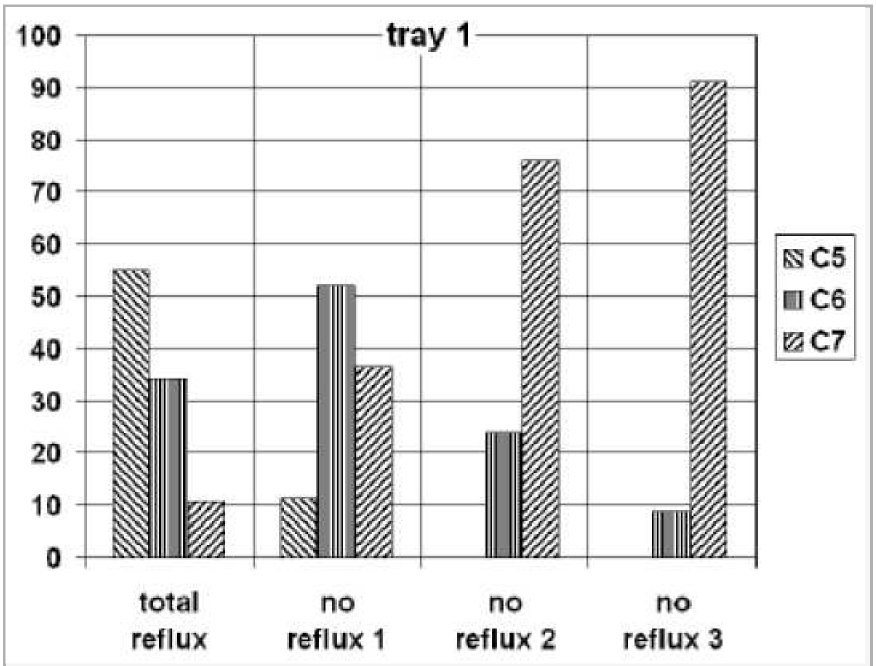


Fig. 12: Comparison of the percental peak area fractions of the hydrocarbons for columntray 1 during distillation with total reflux and with no reflux (at 3 different times).

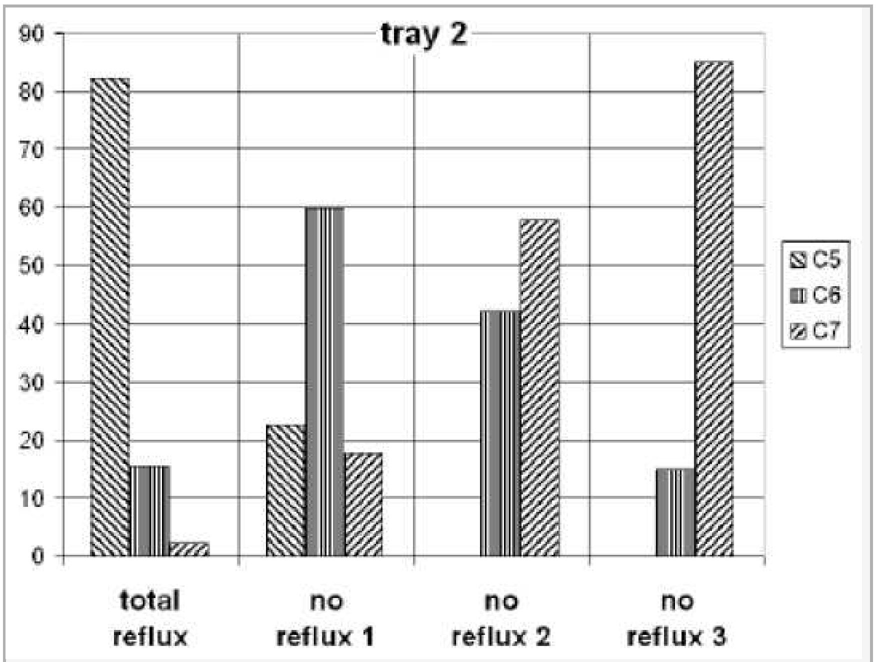


Fig. 13: Comparison of the percental peak area fractions of the hydrocarbons for columntray 2 during distillation with total reflux and and with no reflux (at 3 differenttimes).

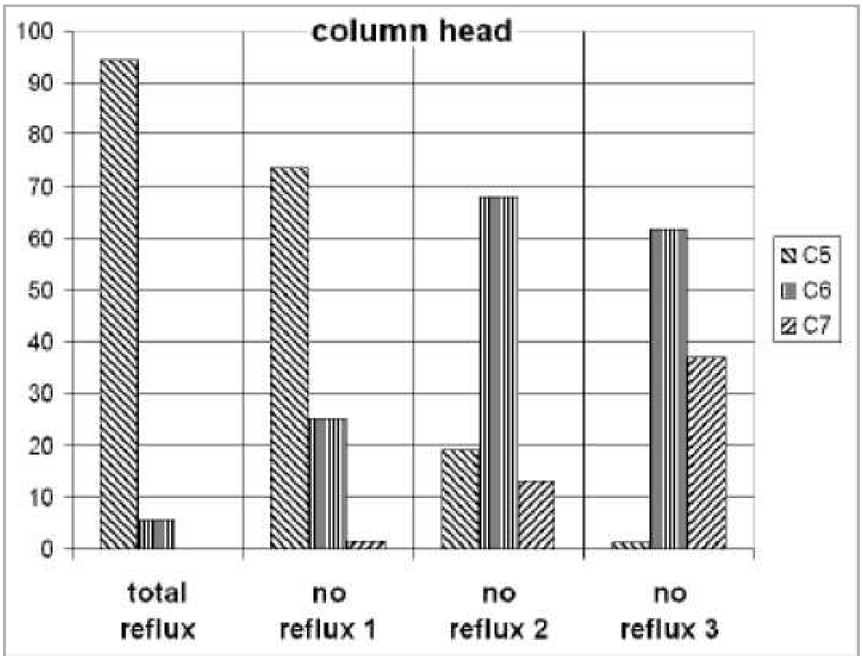


Fig. 14: Comparison of the percental peak area fractions of the hydrocarbons for the columnhead during distillation with total reflux and and with no reflux (at 3 different times).

Data and results

The evaluation in the form of a histogram (Fig. 11) shows that even with only two bubble trays a substantial separation effect can be achieved during a distillation with total reflux, if as in the example selected here the boiling points of the individual components lie relatively far apart. *n*-Pentane has become the main component (around 50%) in the bottom tray (tray 1) of the column, but *n*-hexane and *n*-heptane are also present. In the upper tray (tray 2), there is a great deal of *n*-pentane (around 80%), little *n*-hexane (around 15%) and almost no *n*-heptane (below 5%). In the column head nearly pure *n* pentane (around 95%) with a trace of *n*-hexane (around 5%) has condensed.

During the distillation with no reflux the compositions of the mixtures are changing permanently with time respectively amount of condensate removed from the column. This can be seen in Fig. 12 to Fig. 14. At all three places (tray 1, tray 2, column head) the amounts of the lower boiling components are decreasing and those of the higher boiling components are increasing.

Appendix

Disposal

The organic substances have to be collected in a correspondingly labelled container and passed to safe waste disposal.

Appendix

Hazard symbol, signal word	Hazard statements	Precautionary statements
***n*-Pentane**  	H225: Highly flammable liquid and vapour. H304: May be fatal if swallowed and enters airways. H336: May cause drowsiness or dizziness. H411: Toxic to aquatic life with long lasting effects.	P273: Avoid release to the environment. P301 + 310: IF SWALLOWED: Immediately call a POISON CENTER or doctor/physician. P331: Do NOT induce vomiting. P403 + 235: Store in a well ventilated place. Keep cool.
***n*-Hexane**  	H225: Highly flammable liquid and vapour. H361: Causes mild skin irritation. H304: May be fatal if swallowed and enters airways. H373: May cause damage to organs through prolonged or repeated exposure. H315: Causes skin irritation. H336: May cause drowsiness or dizziness. H411: Toxic to aquatic life with long lasting effects.	P210: Keep away from heat/sparks/open flames/hot surfaces – No smoking P240: Ground/bond container and receiving equipment. P273: Avoid release to the environment. P301 + 310: IF SWALLOWED: Immediately call a POISON CENTER or doctor/physician. P331: Do NOT induce vomiting. P302 + 352: IF ON SKIN: Wash with soap and water. P403 + 235: Store in a well ventilated place. Keep cool.
***n*-Heptane**  	H210: Highly flammable liquid and vapour. H304: May be fatal if swallowed and enters airways. H315: Causes skin irritation. H336: May cause drowsiness or dizziness. 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. P302 + 310: IF SWALLOWED: Immediately call a POISON CENTER or doctor/physician. P331: Do NOT induce vomiting. P302 + 352: IF ON SKIN: Wash with soap and water. P403 + 235: Store in a well ventilated place. Keep cool.