Distillation - Determination of alcoholic contents in wine

Chemistry > Organic chemistry > Distillation & Purification

Difficulty level	Group size	Preparation time	Execution time
easy	1	20 minutes	30 minutes

This content can also be found online at:

http://localhost:1337/c/60508dd01d5969000384bad5

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General information

Application

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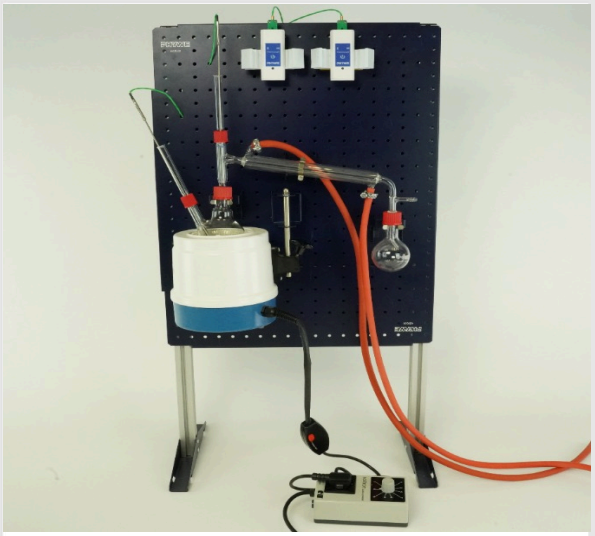

Complete setup of the experiment

Wine is a widely consumed alcoholic beverage. The determination of the alcohol content of wine is based on the density measurement of the liquid. However, due to various ingredients in wine, this method is very inaccurate.

By distilling the alcohol and filling it up to the initial quantity, the alcohol content can be determined very accurately using the density.

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Other information (1/3)

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Prior knowledge

Students should know about the chemical and physical properties of alcohols, especially ethanol. They should also be familiar with physical quantities such as density and volume.

Scientific principle

The boiling temperature of alcohol is lower than that of water, which is why the alcohol evaporates first and only precipitates again later. The density of a liquid depends on all the components it contains.

Other information (2/3)

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Learning objective

This experiment shows both the distillation process and the determination of the alcohol content of a liquid by measuring its density.

Steps

1. Distillation of the wine and separation of the alcohol.
2. Measurement of the density of the distillate and alcohol content determination from it.

Two variants of this experiment are given at the end of the instructions:

a) If increased separation performance is desired

b) Distillation with more than two components that are to be separated

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Other information (3/3)

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Notes

In the context of this school experiment, accuracy was foregone in favor of reduced effort and better clarity. The following systematic errors are committed in the process:

- Distillation up to a boiling point of 100°C. In this process, not only is the alcohol completely transferred, but other volatile components are also transferred to the template. Depending on the components, this can lead to an increase as well as a decrease in the alcohol content.
- Depending on the room temperature, alcohol may evaporate from the template. Cooling of the template would be mandatory. However, this has hardly any effect. It would lead to an increased density and thus to an alcohol content that is too small.

Safety instructions

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- Ethanol is a flammable colourless liquid with a characteristically pleasant odour, which can be mixed at will with water and almost all organic solvents. The vapours can form explosive mixtures with air.
- Keep away from sources of ignition.
- Avoid contact with eyes and skin.
- Suitable protective clothing and goggles should be worn when carrying out the experiment.
- For H- and P-phrases please refer to the safety data sheet of the respective chemical!

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Theory

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Wine is a popular alcoholic beverage

When heating beverages containing alcohol, the alcohol evaporates before other ingredients due to its low boiling temperature. In the Liebig condenser, the alcohol condenses and the alcohol content of the wine can be determined more accurately after topping up the distillate.

The current official method is also based on the distillative separation of alcohol and the subsequent determination of density.

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Equipment

Position	Material	Item No.	Quantity
1	Frame for complete experiments	45500-00	1
2	Rear-cover for compl.-exp. panel	45501-00	1
3	Panel for complete experimental setups	45510-00	1
4	Clamping holder,18-25mm	45520-00	2
5	Clamping holder, turnable, 18-25 mm	45521-00	1
6	Cobra SMARTsense - Thermocouple, -200 ... +1200 °C (Bluetooth + USB)	12938-01	2
7	Clamp on holder	02164-00	1
8	Fixing bands,universal,100 pcs.	45535-00	1
9	Spring plugs, 50 off	45530-00	1
10	G-clamp	02014-00	2
11	Sheath Thermocouple, NiCr-Ni, Type K, -40°C ... +1000°C	13615-06	2
12	Protective sleeves f.temp.probe,2	11762-05	1
13	Round bottom flask, 100ml, GL 25/12	35841-15	1
14	Round bottom flask, 250 ml, 2-neck, GL25/12, GL18/8	35843-15	1
15	Liebig Condenser, with head, GL18/8	MAU-27223000	1
16	Rubber tubing, i.d. 6 mm	39282-00	4
17	Tube Coupling, d = 8 mm	47521-00	2
18	Hose clip, diam. 8-16 mm, 1 pc.	40996-02	6
19	Hose clip f.12-20 diameter tube	40995-00	1
20	Heating mantle f. roundbottom flask, 250ml	49542-93	1
21	Clamp for heating mantle	49557-01	1
22	Power regulator, 230 V, with phase controlled modulator	32286-93	1
23	Funnel, glass, top dia. 80 mm	34459-00	1
24	Boiling beads, 200 g	36937-20	1
25	Graduated cylinder, Borosilicate, 100 ml	36629-00	1
26	Hydrometer, 0.800-1.000,	38254-52	1
27	Wash bottle, plastic, 500 ml	33931-00	1
28	Water, distilled 5 l	31246-81	1
29	Temperature meter digital 4 - 2 DEMO with magnetic adhesive tape and universal power supply	13618-88	1
30	Hydrometer, 1.000-1.200, m	38254-53	1
31	Holder for Cobra SMARTsense, magnetic	12960-10	2
32	measureAPP - the free measurement software for all devices and operating systems	14581-61	1

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Additional equipment

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Red wine	100 ml

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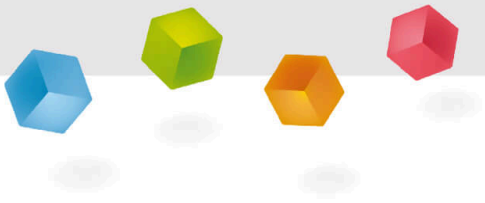

Setup and procedure

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Set-up (1/2)

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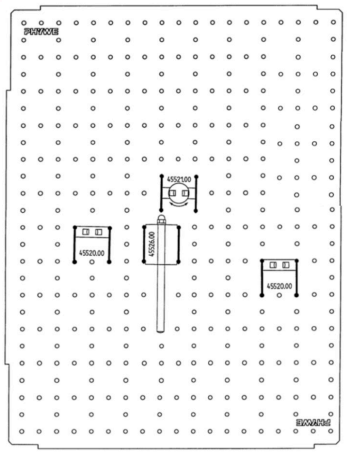

Attaching the holders to the plate

The holders are to be attached to the panel for complete experiments as shown in the illustration and secured with the spring plugs on the back of the plate. The appliance is then set up as shown in the illustration on the following page and attached to the holder.

The sensors are to be connected by cable to the Cobra SMARTsense Thermocouple and attached to the plate with the magnetic holder. If possible, the cables should be routed behind the wall.

Set-up (2/2)

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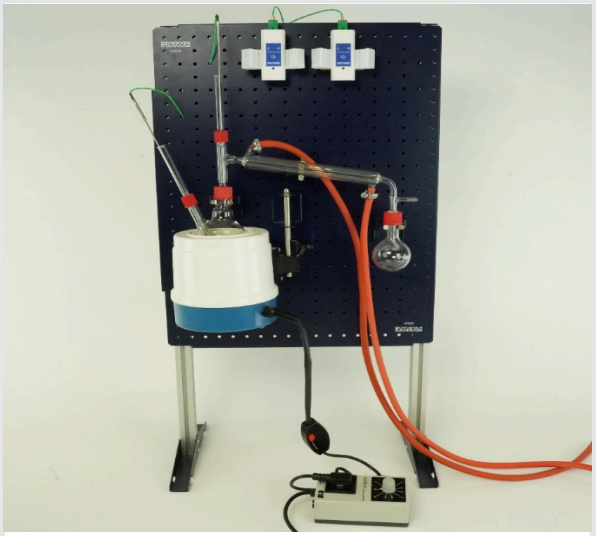
The hoses for the cooling water are to be connected to the cooling jacket. In order to be able to quickly disconnect the water tap from the water drain, two hose couplings are mounted in the hose connections. All hose connections are secured against slipping with hose clamps and fixed to the plate with fastening tape.

Before starting the test, the Cobra SMARTsense Thermocouple must be connected to a device for evaluation. To do this, start the measureLAB program and wait for a pop-up menu. In this menu, devices and the test to be performed can be selected.



Complete setup of the experiment

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Procedure (1/2)

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Measure 100 mL of wine in the measuring cylinder and determine its density approximately with a hydrometer (it may be necessary to use a hydrometer with a measuring range greater than 1 g/cm³). After pouring the wine into the 250 mL flask, add about 5 boiling stones.

When the Cobra SMARTsense thermocouple sensors are connected to measureLAB , the measurement can be started. The house heating mantle is set to maximum power and the power controller is set to the highest level until the first bubbles indicate that the wine is boiling. Then the controller is set to level 8. The distillation continues until a temperature of approximately 98°C to 100°C is reached at the top of the Liebig condenser (duration approximately 35 minutes).

Procedure (2/2)

Density / $g \cdot cm^3$	wt% Ethanol	Vol% Ethanol	Density / $g \cdot cm^3$	wt% Ethanol	Vol% Ethanol
1,00000	0	0	0,98653	8	10,0
0,99813	1	1,3	0,98505	9	11,2
0,99629	2	2,5	0,98361	10	12,4
0,99451	3	3,8	0,98221	11	13,6
0,99279	4	5,0	0,98084	12	14,8
0,99113	5	6,2	0,97948	13	16,1
0,98955	6	7,5	0,97816	14	17,3
0,98802	7	8,7	0,97687	15	18,5

The distillate is transferred into the (rinsed) 100 ml measuring cylinder, residues of the distillate are also transferred into the cylinder using distilled water. The measuring cylinder is then filled up to 100 ml with distilled water. The measuring cylinder is passed around the class to test the odour.

The density is determined with the hydrometer and the alcohol content is read from the table.

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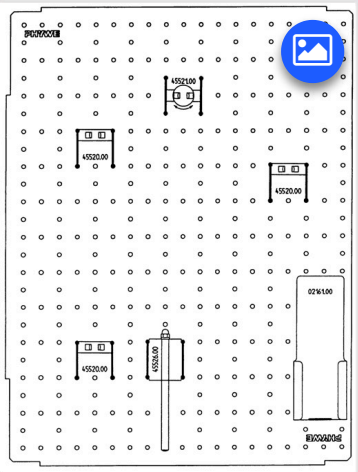
Variant: Increased separation efficiency



Structure of the holders

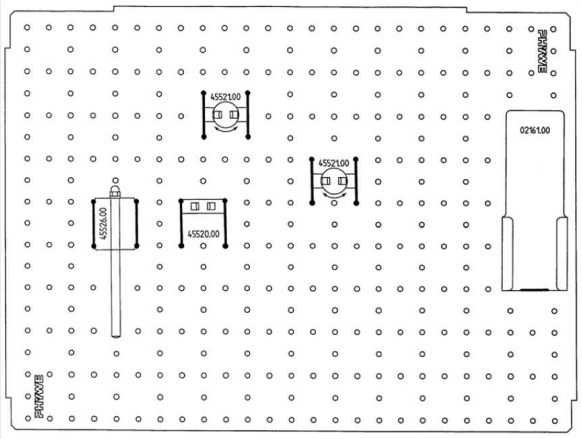
To increase the separation efficiency of the distillation apparatus, a column is used for distillation. For this purpose, additional equipment is required:

Clamp holder, d = 18...25 mm	45520-00	2
Vigreux column, GL 25/12	35792-15	1

The setup pretty much equals the standard experiment. However, the Vigreux column is connected between the 250 ml flask and the Liebig condenser.

In addition to the modified experimental setup, the distillation time with the Vigreux column is extended to a total of about 45 min. This is due to the necessary adjustment of the balance in the column. Otherwise, the execution and evaluation of the experiment remain identical.

Variant: More than two components to be separated (1/2)



Structure of the holders

For the separation of mixtures with more than two components, a fractional distillation with a possibility to collect several distillate fractions should be carried out. For this purpose, the following is additionally required:

Clamp holder, d= 18...25 mm, rotatable	45521-00	1
Short Path Cooler, with top, GL 18/8	MAU-27224500	1
Distillation receiver, for 4 flasks GL 25/	MAU-27227500	1
Flask, 50 mL, GL 25/12	35840-15	4

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Variant: More than two components to be separated (2/2)

This is not needed:

Clamp holder, d= 18...25 mm	45520-00	2
Flask, 100 mL, GL 25/12	35841-15	1
Liebig cooler, with top GL 18/8	35795-15	1

The setup pretty much equals the standard experiment. However, instead of the Liebig condenser, the distillation template with four flasks is used.

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