

Teacher packs in Experimental Science

CHE Pack 2

Distillation of rubbing alcohol (2-propanol) and water mixture

Pack contents

- A. Teacher's Guide
- B. Students Guide
- C. Assessment – Student's sheet
- D. Extensions to experiment
- E. Links to other packs
- F. Health and Safety
- G. Evaluation of pack

Curriculum areas covered:

- Physical and chemical changes
- Compounds, mixtures, solute and solvents
- Homogenous and heterogeneous mixtures

Title: Distillation of rubbing alcohol (2-propanol) and water mixture

Target group: Teacher Trainees (DBE)

Also suitable for: SHS students

Duration:

Learning outcomes:

These are the learning outcomes expected after students have gone through this Pack.

1. Knowledge and understanding

KN1 define the term distillation

KN2 list the types of distillation

2. Cognitive skills

CS1 demonstrate knowledge and understanding of the concept of distillation.

CS2 to predict which of the solvents in the mixture would be distilled first.

3. Key Skills

KS1 identify that liquid-liquid mixtures can be separated

4. Practical skills

PS1 assemble the distillation set up for the separation purpose

PS2 record observations based on the experiment

A. Teacher's Guide

Purpose:

The experiment is to help with the separation of liquid-liquid mixture.

Notes

If heating is done slowly and carefully, students should obtain three separate fractions of liquid. Fraction 1 appears to be pure rubbing alcohol having a boiling point of about 81°C; fraction 2 would be a mixture of substances similar to the original solution; and fraction 3 would be a pure substance with a boiling point the same as water. (Actually, if properly collected, fraction 1 is a constant boiling azeotrope that is 90% alcohol and 10% water with a constant boiling point of 80.5°C. It cannot be further separated by distillation, and thus it has the appearance of a single substance. Do not dwell on the purity of this fraction but emphasize that a separation has occurred).

The initial heating and subsequent graph of temperature versus time are keys to determining the temperature ranges over which to collect the separate fractions. There are two distinct plateaus or flat segments indicating that there are two different substances in the mixture, leading to the suggestion that three fractions should be collected to separate the two substances. Fraction 1 should be collected from about 78-82°C, Fraction 2 from 82°C to about the boiling temperature of water, and Fraction 3 beginning at about the boiling point of water. (The boiling point of both liquids depends upon atmospheric pressure at time of the activity. Boiling points are lowered by a decrease in pressure).

B. Student Guide

Purpose:

The experiment is to help with the separation of liquid-liquid mixture.

Background Information

Distillation is an extremely useful technique that is used to purify and separate liquid-liquid mixtures. There are three common types of distillation – simple, fractional and steam distillation.

Simple distillation is used to separate the components of a liquid-liquid mixture if the boiling points of the liquids are further apart. If the boiling points of the liquids are closer together then fractional distillation has to be used. Steam distillation is used to separate an immiscible mixture of essential oil and water.

In each of the processes, the liquid mixture is placed in the distilling flask as shown in Figure 1. As the flask is heated, the lower boiling liquid vaporizes faster than the higher boiling liquid. Thus, although both components are in the vapor phase, the vapor is richer in the lower boiling liquid. The resulting vapor could be condensed and re-evaporated making the resulting vapor still richer in low boiling liquid. If the process is repeated a sufficient number of times, a separation of the two volatile components can be achieved

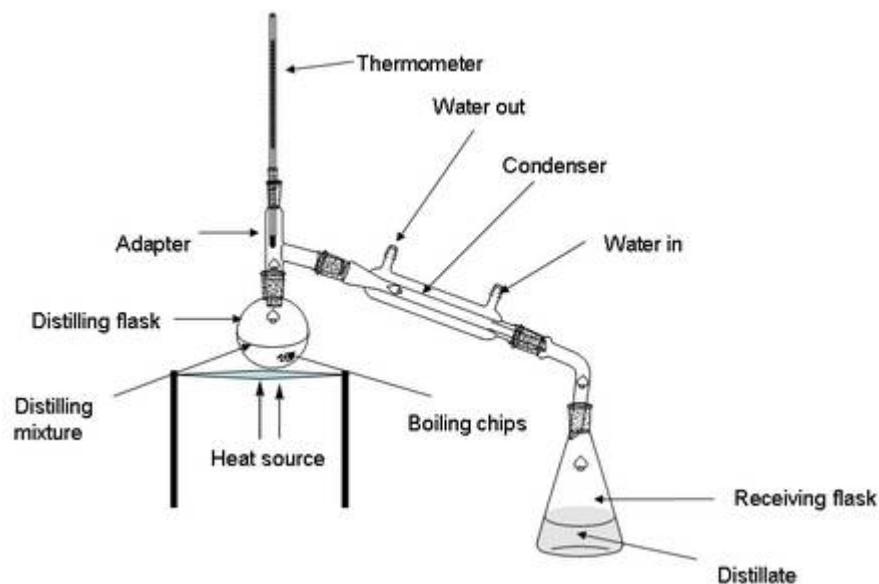


Figure 1. Distillation of rubbing alcohol and water mixture

Equipment/ Materials needed

- Bunsen burner or source of heat
- 250 ml conical flask or round bottom flask – distilling flask
- Tripod stand
- Wire gauze
- Thermometer
- boiling chips
- Liebig condenser fitted with rubber tubings
- Water source
- 3 small receptacles (small beakers or conical flasks)
- Rubbing alcohol
- Distilled water

Other requirements

Practical notebook/ Writing material. Working bench/table, Open space, Laboratory coat, Eye goggles, Hand gloves

Experimental Procedure

1. Work with a partner/ in a group
2. Add a few boiling chips to the mixture in the distilling flask
3. Mount your set up with the mixture in the distilling flask as in Figure 1. [Ask for help from your instructor when challenged]
4. Make sure there is continuous flow of water
5. Heat the mixture carefully and slowly and allow it to boil.
6. Record the temperature at which the first fraction is collected into the receiving flask. [The temperature would remain constant for a while].
7. Change the receiver after you observe a change (what difference between this and temp in step 5?) in the temperature.
8. Collect each fraction of the distillate into separate labeled receiving flask
9. Remove the heat source when the distilling flask is almost empty and allow to cool.
10. Dismantle set-up carefully and tidy up

Reflection on the experiment

1. What do you think will happen when the round bottom flask is filled to the brim with the mixture to be separated? is filled to the brim in the round bottom flask?
2. Why were the fractions collected in different flasks?
3. What is the purpose of the boiling chip in the experiment?

C. Assessment – Student's sheet

On completion of the experiment, you should answer the following questions:

1. Define the term distillation (KN1)

2. List the types of distillation (KN2)

3. What type of distillation can be used to separate the following liquid-liquid mixtures? (CS1)
 - a) palm oil and water
 - b) kerosene and water
 - c) palm wine and ethanol
 - d) diethyl ether and ethanol

D. Extensions to experiment

- In the **distillation of crude oil**, the different fractions are condensed out at different points in a huge fractionating column. Give examples of the distillate produced. What type of distillation is employed here?
- Complete the table below by checking the properties of the solutions

Property	butanol	water
Odor		
Boiling point		
Dissolve in common salt		
Dissolve in naphtha		

E. Useful links

- www.ncsu.edu/sciencejunction/depot/experiments/water/lessons/ph/index/html
- www.sciencepark.etacude.com/projects/php
- Orna, M. V., Schreck, J.O. and Heikkinen, H. Eds. (1998). Welcome to Reactions in Chemistry. *ChemSource* Version 2.1. New Rochelle, NY,

F. Health and Safety

BASIC SAFETY RULES:

- Do not eat, drink or chew whilst doing the experiment.
- Keep your face at a safe distance from open flames and heated solutions. Never look into a heated solution from above.
- Avoid breathing in dust or vapour. When smelling solutions, gently wave the air above the solution towards your nose with your hand.
- Wash any spilled solutions from your skin with plenty of water, and notify the instructor.
- Report any accident, no matter how minor, to the instructor/report the nearest health post.

Compulsory rules

You will not be allowed to do the experiment unless you are wearing the following items:

- Long-sleeved overcoat that is long enough to cover the hips, worn closed at all times.
- Safety glasses. Please note that contact lenses do not provide eye protection and in some cases may complicate an emergency (caustic liquids which splash into the eye can be

trapped behind the contact lens). You are advised to avoid wearing contact lenses in the laboratory, if possible.

- c. Closed, flat-heeled shoes (no open sandals).
- d. Long hair and loose scarves must be tucked away or tied up.
- e. If you are using toxic or corrosive chemicals you use protective gloves.

Tidy working

Keep your working area tidy. A cluttered bench is a common contributory factor to accidents. Cleaning the glassware after use should be done immediately. This prevents the organic tarry material from attacking the surface of the glass.

Always clean up a chemical spill without delay

Clean up and dispose off your unknown substances according to your teacher's instructions.

G. Evaluation

- a. Was it difficult/easy to have access to the experimental materials listed?
- b. Were the experimental procedures easy to follow? Explain.
- c. Suggest other methods and materials which can be included in this pack.