

Experiment 2:

Purifying Chemicals by Distillation

Xiaofen Lu

8225592

Partner: Tran Khanh Ha Ho 8151821

CHM 1321 Section C6

Demonstrator: Camilo Viasus

Introduction:

In this experiment two different methods of distillation are used, simple distillation and fractional distillation.

In simple distillation, the mixture is heated up, and the compound with the lower boiling point will change from liquid into vapour. When the vapour passes the condenser tube, the flowing cold water will cool down the vapour, thus, causing the vapour to change back into liquid. The liquid slowly drips into the receiving flask. Overall, we are separating the two compounds by using their different boiling points.

Fractional distillation uses the same concept of simple distillation. However, the vapour has to migrate through a fractionating column before it travels into the condenser. The fractionating column provides a surface for the vapor to condense.

Procedure:

Please refer to "CHM 1321 Lab Manual 2016 'CHM 1321 Organic Chemistry Laboratory'" page 26, by Dr. Rashmi Venkateswaran.

Observations:

Table 1. Volume and Temperature of simple distillation for 50mL of 50:50 mixture of 2-propanol and 1-butanol.

Volume(mL)	Temperature (°C)
0	86.3
2	88.3
4	89.1
6	89.6
8	91.4
10	92.0
12	93.2
14	94.2
16	95.5
18	96.7
20	98.1
22	99.5
24	101.2
26	104.6
28	105.6
30	107.9
32	110.1
34	112.2
36	114.0
38	115.1

40	115.9
42	116.4
44	116.8
46	117.1
48	122.0

Graph1. Volume vs. Temperature of simple distillation for 50mL of 50:50 mixture of 2-propanol and 1-butanol.

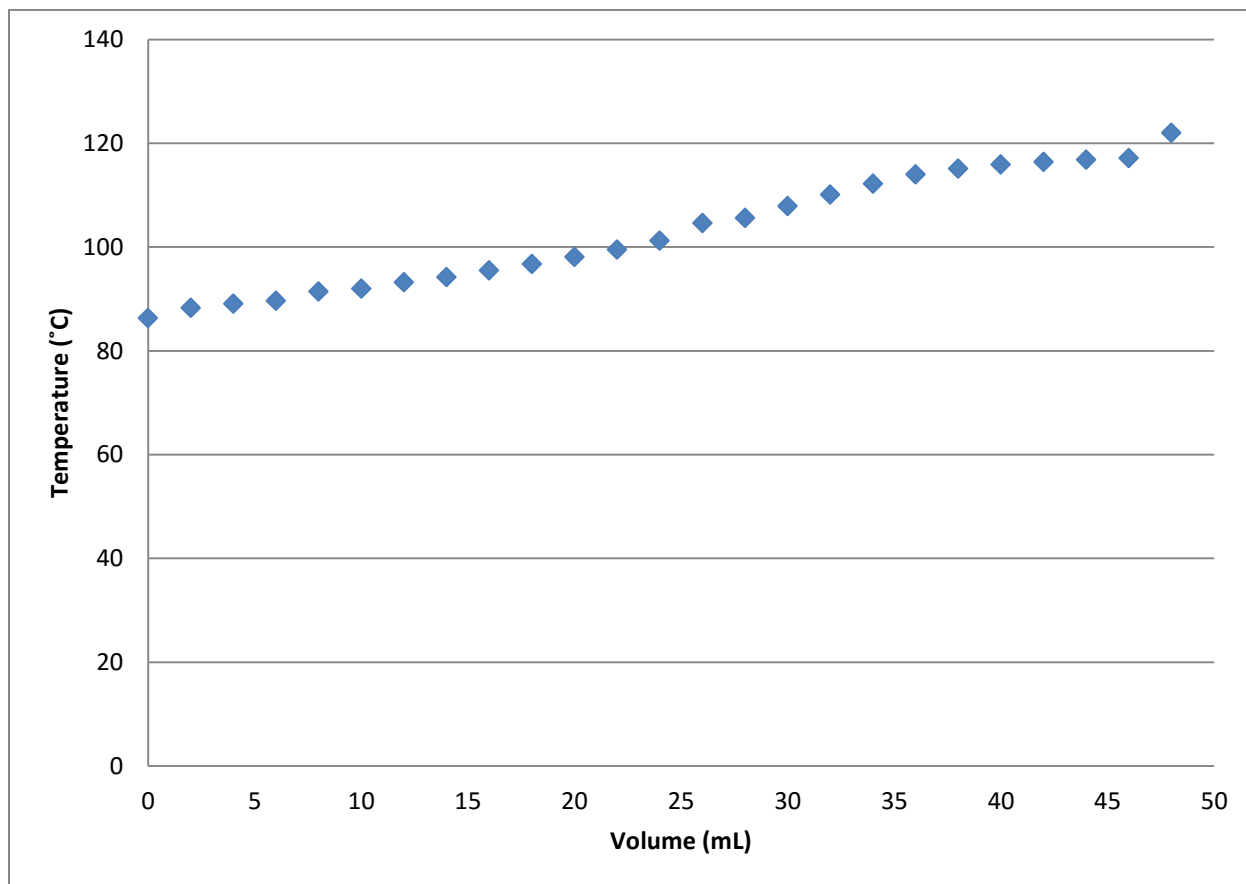
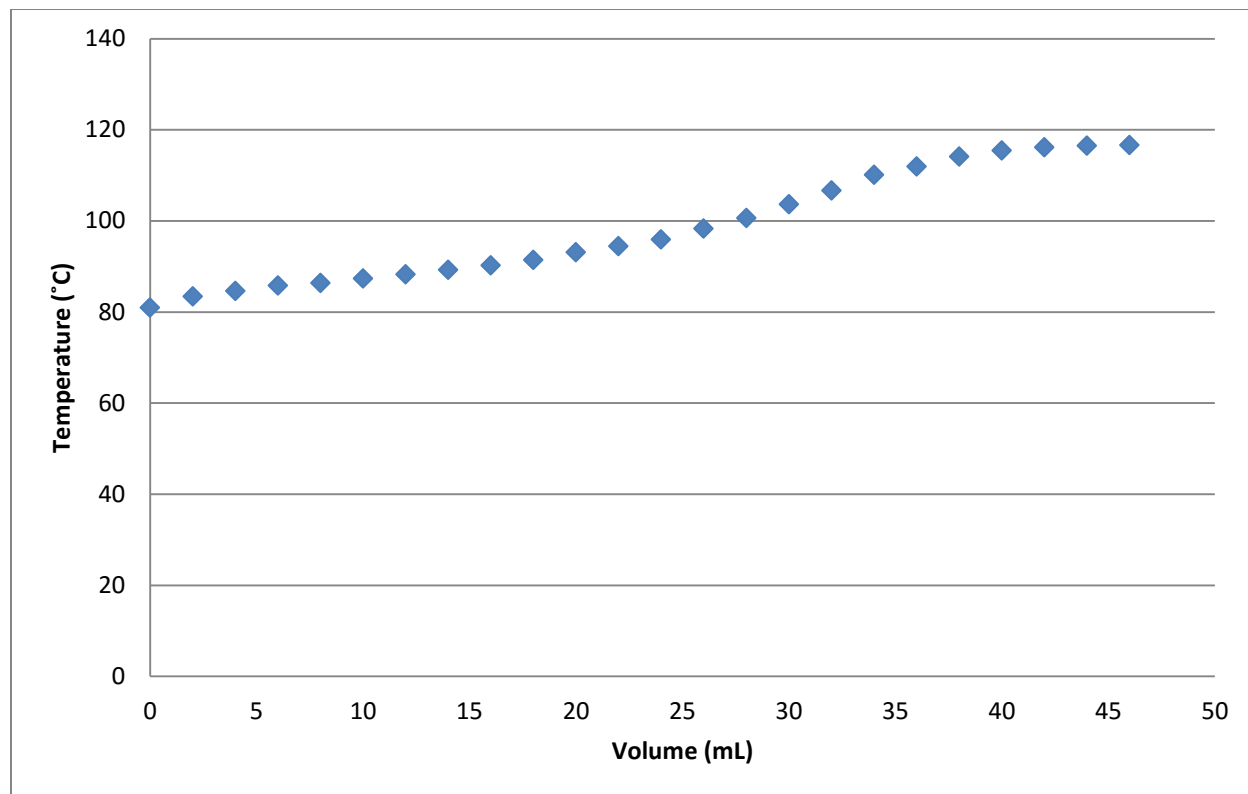


Table 2. Volume and Temperature of fractional distillation for 50mL of 50:50 mixture of 2-propanol and 1-butanol.

Volume(mL)	Temperature (°C)
0	80.9
2	83.4
4	84.6
6	85.8
8	86.3
10	87.3
12	88.2
14	89.2
16	90.2
18	91.4
20	93.1
22	94.4
24	95.9
26	98.3
28	100.6
30	103.6
32	106.6
34	110.1
36	111.9
38	114.1
40	115.4
42	116.1
44	116.5
46	116.6

Graph 2. Volume vs. Temperature of fractional distillation for 50mL of 50:50 mixture of 2-propanol and 1-butanol.



Note: 0 mL is the initial drop.

Discussion:

We can see that the slope is close to being linear in the graph for simple distillation. The temperature rises steadily according to the amount of distillate obtained. This graph follows what is generally seen in simple distillation, as the mixture is being heated, the temperature increases throughout the whole process, because the composition of the vapor varies constantly.

In graph 2, we can see the temperature rises to around 91 °C in a steady motion, but accelerates a little after that. The separation means the first component, 2-propanol, has been collected, then the temperature rises to the boiling point of the second component, 1-butanol. When the temperature stops to increase, this means the boiling point of the second component has been reached, and this point, most of the 1-butanol should be collected.

Simple distillation takes less time than fractional distillation. However, fractional distillation is much more efficient, because of the multiple simple distillations taking place at the same time. Simple distillation is better for mixtures with components that have large difference in boiling points.

Sources of error:

- When the drops drip down, the temperature may have changed when read.
- The mantle did not work at first, and the mixture would not boil.
- Some drops of the mixture may have got stuck in the condenser.
- The temperature probe may have been touching the walls of the column without us noticing.

Questions:

- 1) The component with the higher boiling point will flow back down the fractioning column as liquid, and the component with the lower boiling point will move through the column as vapour. The liquid that flows back down will return to the distillation flask, this way, after multiple cycles, the receiving flask will mainly contain the component with lower boiling point, and the component with higher boiling point will mainly be in the distillation flask. This allows the distillation to be much more efficient.
- 2) The distillation process can be altered with the variations of the temperature. The liquid would not flow back if the temperature is too high, this will cause the purity of the liquid obtained in the receiving flask to go down.
- 3) When a liquid is boiling, it is to be thought that the liquid has reached the pressure of its environment, thus vapour pressure of benzene should be 1 atm.
- 4) Like said in question 3, an increase in atmospheric pressure may result in a higher boiling point of the liquid, also as stated in the ideal gas law.
- 5) If the water enters from the top, it would quickly flow to the exit without filling up the condenser, hence losing the purpose of cooling the vapour down. However, if we let the water enter from the bottom, the water is forced to fill up the condenser before exiting at the top.
- 6) $P_A = (P_A)(N_A) + (P_B)(N_B)$
 $= (350 \text{ mmHg})(0.75) + (150 \text{ mmHg})(0.25)$
 $= 300 \text{ mmHg}$
 The vapour pressure of the 3:1 mixture is 300 mmHg.

Raw Data:

Xiaofen Lu

①	volume (ml)	Temp. (°C)
	0	86.3°
	2	88.3
	4	89.1
	6	89.6
	8	91.4
	10	92.0
	12	93.2
	14	94.2
		95.5
		96.7
		98.1
		99.5
		101.2
		104.6
		105.6
		107.9
		110.1
		112.2
		114.0
		115.1
		115.9
		116.4
		116.8
		117.1
		122.0

✓ 4.8ml

✓

Camilo

② Xiaofenlei

Volume (mL)	Temp (°C)
0	80.9
2	83.4
4	84.6
6	85.8
8	86.3
9	87.3
10	88.2
12	89.2

90.2
91.4
93.1
94.4
95.9
98.3
100.6
103.6
106.6
100.0
111.9
114.1
115.4
116.1
116.5
116.6

46 mL

Cambio