

# **Experiment 2**

## **Purifying Chemicals by Distillation**

**February 9, 2016**

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## Procedure

Refer to Organic Chemistry lab manual page 26. No changes have been made.

## Observations

- The mixture of propanol and butanol smells like white-board marker.
- The mixture was also clear and colorless.
- When the mixture was dropping in the receiving flask, each drop created wave-like shapes in the liquid.
- Boiling point of 2-propanol: 82.6°C. Boiling point of 1-butanol: 117.4°C<sup>1</sup>

## Tables

**Simple Distillation.**

<b>Volume (mL)</b>	<b>Temperature (°C)</b>
0	21
2	25.3
4	30.0
6	88.0
8	90.0
10	92.9
12	93.3
14	94.7
16	95.7
18	96.9
20	98.3
22	99.3
24	101.4
26	103.0
28	105.2
30	106.5
32	109.1
34	111.2
36	113.1
38	115.9
40	117.3
42	118.4
44	117.8
46	103.9
47	94.8

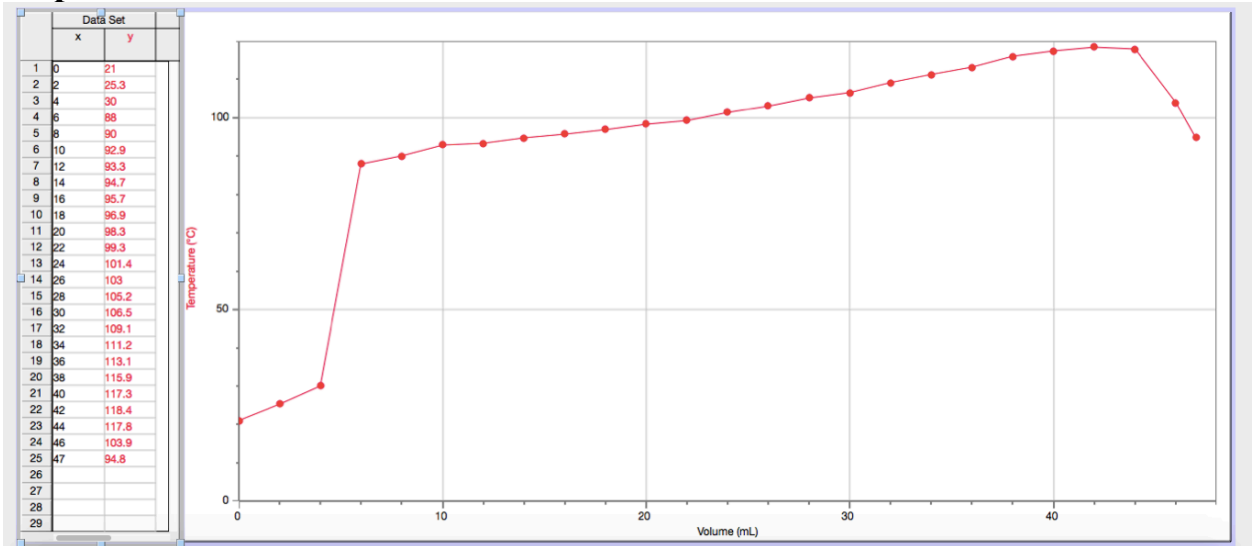
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<sup>1</sup> [https://en.wikipedia.org/wiki/Isopropyl\\_alcohol](https://en.wikipedia.org/wiki/Isopropyl_alcohol)

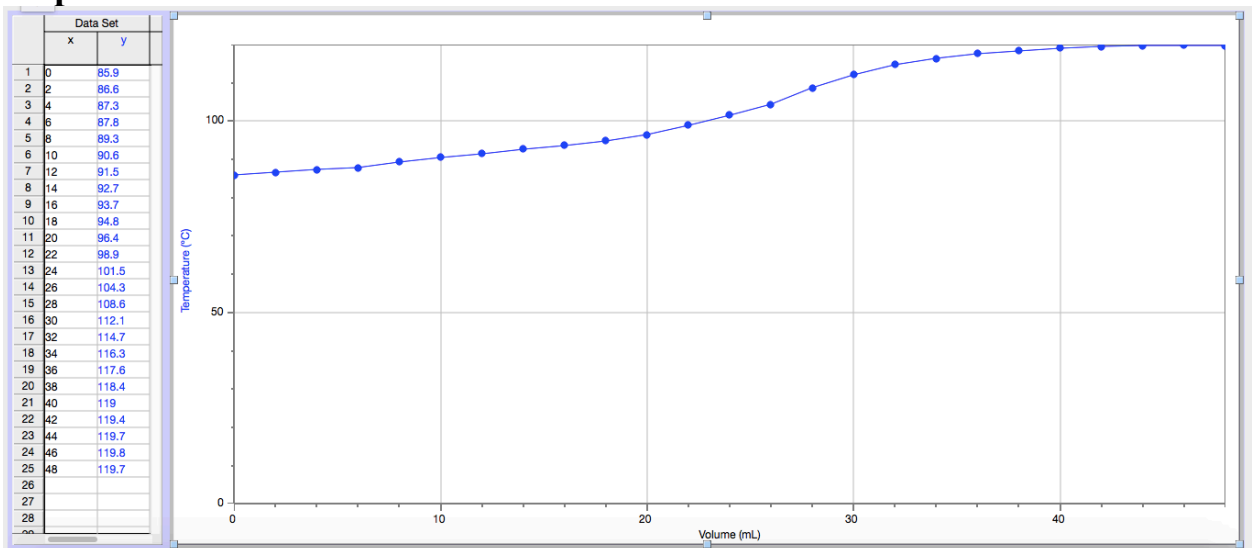
### Fractional Distillation

<b>Volume (mL)</b>	<b>Temperature (°C)</b>
0	85.9
2	86.6
4	87.3
6	87.8
8	89.3
10	90.6
12	91.5
14	92.7
16	93.7
18	94.8
20	96.4
22	98.9
24	101.5
26	104.3
28	108.6
30	112.1
32	114.7
34	116.3
36	117.6
38	118.4
40	119.0
42	119.4
44	119.7
46	119.8
48	119.7

**(A) Simple distillation curve: a representation of the temperature as a function of volume measured every two minutes throughout the procedure.**



**(B) Fractional distillation curve: a representation of the temperature as a function of volume measured every two minutes throughout the procedure.**



## Discussion

- Temperature in both sets of graphs gradually increases as time passes by, and tends to either plateau or decrease at the end of the distillation process.
- Simple distillation is used to separate a mixture into its components. Best results are seen when the substances involved have a high difference between their boiling points.
- Fractional distillation uses a “Fractional column” to aid in the separation of substances that have almost the same boiling points
- A simple distillation curve should appear linear on a graph because the process is steady, which is not the case here. This was due to an issue caused by the thermometer during the experiment and so measurements were not accurate.
- In a fractional distillation curve, we would expect to see steep changes in temperature due to the presence of an inert material with high surface area.
- The small curve seen in graph B represents the time at which the liquid with the lowest boiling point (2-propanol) was removed and the liquid with the high boiling point (1-butanol) remained in the flask.
- The fractional distillation curve does not show any steep changes here, and this can be due to many sources of errors.
- One source of error was that during the procedure, the thermometer malfunctioned and was replaced with a new one. This can cause inaccurate readings of temperature
- Another source of error could be that the distilling flask was heated too fast and at a high temperature.
- Contamination of the container that the mixture was held in could also be another source of error because if there were other substances mixed with the 2-propanol and 1-butanol, this can change the distillation curve.

## Questions

- (1) Liquid must be flowing back through the fractionating column because as the vapor reaches to the point where it starts to enter the column, the liquid will assist in condensation and lowering of the temperature.
- (2) Temperature control is key in distillation. It would make sense to have the fractionating column insulated in order to keep a controlled constant

temperature. If the temperature increases or decreases to a certain level, this can hinder the distillation process because it can either evaporate or condensate the substances, thus causing them not to separate properly.

- (3) 81°C is the boiling point of benzene. A liquid at its boiling point has the same vapor pressure as the atmospheric pressure. So the vapor pressure of benzene is 1 atm.
- (4) The increase in atmospheric pressure would increase the boiling point of a liquid because the atmospheric pressure and the vapor pressure of liquids should be ideally equal.
- (5) Filling water from the bottom opening of the condenser would make sense because then gravity will act on the flowing water and as more water is pushing through the hose, it will eventually reach the top. If water was filled through the top opening, the highest portion of the condenser might not be completely filled with water because the condenser is tilted.

(6) Raoult's Law<sup>2</sup>:

$$P_A = (P_A^\circ) \times (N_A)$$

$$P_B = (P_B^\circ) \times (N_B)$$

$$P_{\text{total}} = P_A + P_B$$

$$\begin{aligned} P_{\text{Total}} &= [(P_A^\circ) \times (N_A)] + [(P_B^\circ) \times (N_B)] \\ &= [(350 \text{ mmHg}) \times (0.75)] + [(150 \text{ mmHg}) \times (0.25)] \\ &= (262.5) \times (37.5) \\ &= 300 \text{ mmHg} \end{aligned}$$

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<sup>2</sup> Organic Chemistry Lab manual page 21.

# Raw Data

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## Purifying Chemicals by Distillation

### Raw Data

- 50 mL of 50:50 mixture of 2-propanol & 1-butanol in distillation flask.

temp at ~~0 mL~~ 2 mL = 21°C

temp at 2 mL =

temp at 4 mL =

temp at 6 mL = 28°C

temp at 8 mL = 33.9°C

temp at 10 mL = 38.9°C

temp at 12 mL = 43.3°C

temp at 14 mL = 47.7°C

temp at 16 mL = 51.7°C

temp at 18 mL = 56.9°C

temp at 20 mL = 62.3°C

temp at 22 mL = 67.3°C

temp at 24 mL = 71.4°C

temp at 26 mL = 75.0°C

temp at 28 mL = 79.2°C

temp at 30 mL = 83.5°C

temp at 32 mL = 87.1°C

temp at 34 mL = 91.2°C

temp at 36 mL = 95.1°C

temp at 38 mL = 99.9°C

temp at 40 mL = 103.3°C

temp at 42 mL = 107.4°C

temp at 44 mL = 111.8°C

temp at 46 mL = 103.9°C

temp at 48 mL = 94.8°C

small imperfections in  
be liquid. This process  
more will usually not  
super saturation, and  
about them above the  
then form violently  
in. The potentially  
the

each of the distillations. In your report discussion,  
compare the distillation of the mixture by simple and  
fractional methods. As discussion points you should  
consider the equipment required, the difficulty of the  
technique, the purity of the products and the nature of the  
starting mixture.

### Observations

- mixture of 2-propanol & 1-butanol smells like white-board marker.
- when mixture was dripping in receiving flask, each drop created wave-like shapes

### Fractional distillation

temp at 0 mL = ~~21°C~~ 25.9°C

temp at 2 mL = 26.6°C

temp at 4 mL = 27.3°C

temp at 6 mL = 27.8°C

temp at 8 mL = 29.3°C

temp at 10 mL = 30.6°C

temp at 12 mL = 31.5°C

temp at 14 mL = 32.7°C

temp at 16 mL = 33.7°C

temp at 18 mL = 34.8°C

temp at 20 mL = 36.4°C

temp at 22 mL = 38.9°C

temp at 24 mL = 40.5°C

temp at 26 mL = 42.3°C

temp at 28 mL = 43.6°C

temp at 30 mL = 44.1°C

temp at 32 mL = 44.7°C

temp at 34 mL = 46.3°C

temp at 36 mL = 47.6°C

temp at 38 mL = 48.4°C

temp at 40 mL = 49.0°C

temp at 42 mL = 49.4°C

temp at 44 mL = 49.7°C

temp at 46 mL = 49.8°C

temp at 48 mL = 49.7°C