Protocole: Refer to lab manual "Experiment 2: Purifying Chemicals by Distillation" pages 25-27

Observations:

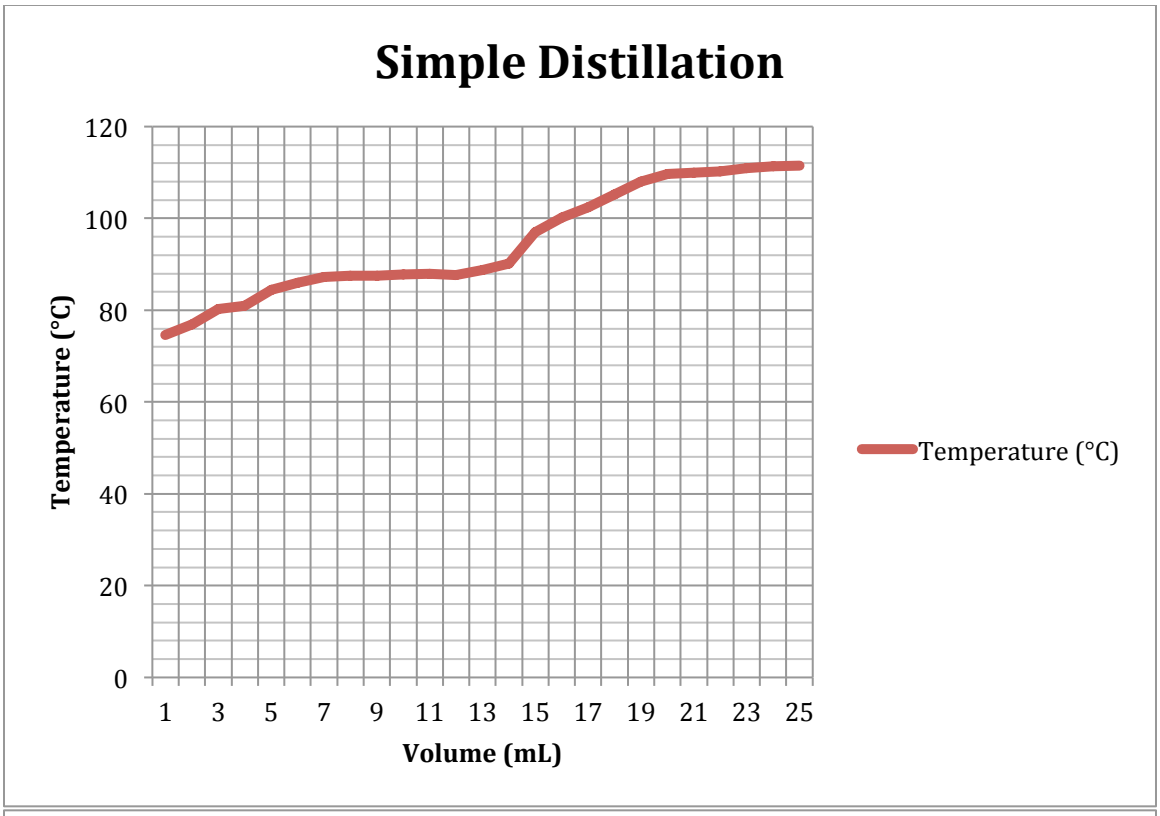
50:50 mixture of 2-propanol and 1-butanol: clear, colorless

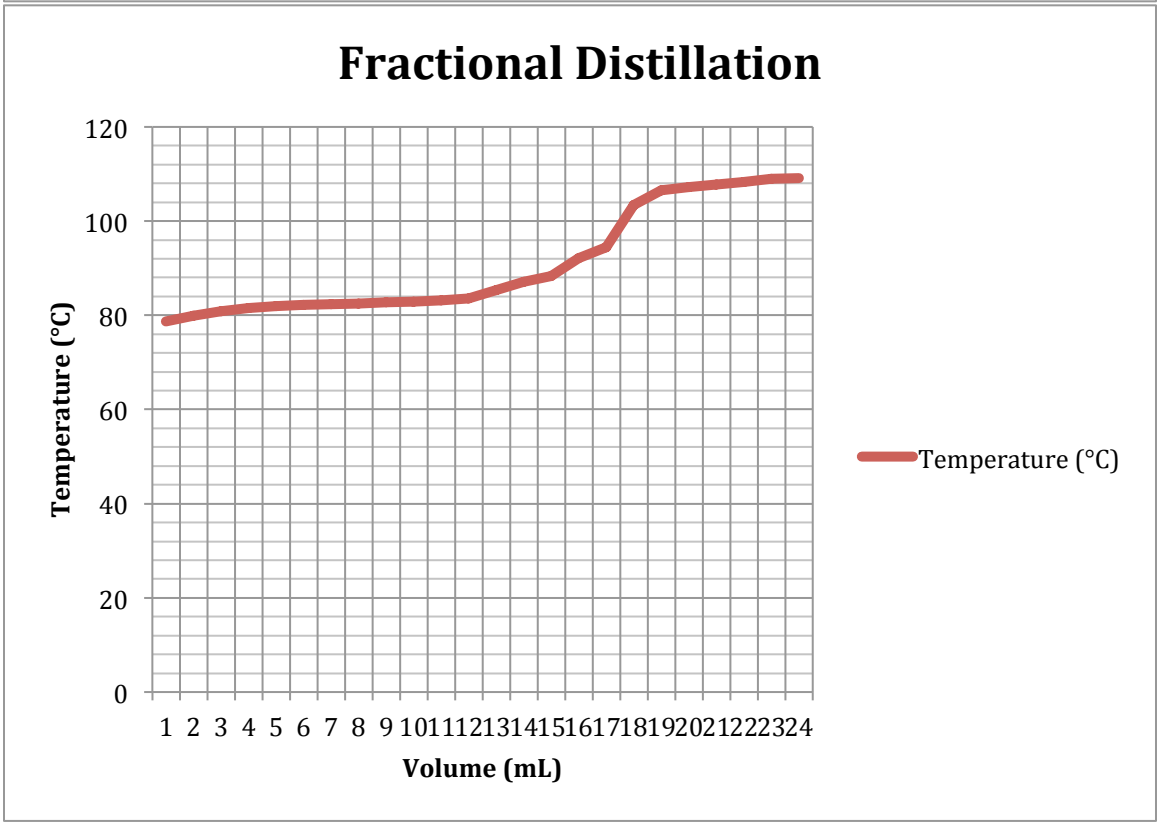
Table 1: Simple Distillation

Volume(mL)	Temperature (°C)
1	74.6
2	76.9
3	80.2
4	81
5	84.4
6	86
7	87.2
8	87.5
9	87.5
10	87.8
11	87.9
12	87.7
13	88.8
14	90.1
15	97
16	100.2
17	102.4
18	105.2
19	108
20	109.7
21	110
22	110.3
23	111
24	111.3
25	111.5

Table 2: Fractional Distillation

Volume(mL)	Temperature (°C)
1	78.7
2	79.9
3	80.8
4	81.5
5	81.9
6	82.2
7	82.3
8	82.5
9	82.7
10	82.9
11	83.2
12	83.6
13	85.3
14	87.1
15	88.3
16	92.1
17	94.4
18	103.4
19	106.5
20	107.2
21	107.8
22	108.3
23	109
24	109.1
25	//////////////


Simple Distillation
120
100
80
60
40
20
0
Temperature (°C)
1 3 5 7 9 11 13 15 17 19 21 23 25
Volume (mL)
Temperature (°C)


Fractional Distillation
120
100
80
60
40
20
0
Temperature (°C)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Volume (mL)
Temperature (°C)

Discussion:

The fractionating column provides surface area for the vapour to condense on. The more surface area there is, the better the separation. When the liquid flows back down the fractionating column, this is called reflux. At this point the liquid is becoming enriched in the higher boiling point component. The liquid flowing downwards is providing the cooling needed to further condese the liquid flowing upwards. The liquid will become more and more enriched leading to more purity and a better separation.

The insulation in a fractionating column is required to prevent heat loss. This temperature gradient that is trying to be achieved allows for a particular fraction to travel up the column at a given temperature without having to condense and drop back down if it reaches a cooler spot near the top. This temperature gradient allows for the molecules with a higher boiling point to re-condense and drip down while the lower boiling point molecules are still capable of rising up to be distilled by the warm vapour rising up. If there is not a proper gradient, there could be condensing of the lower boiling point molecule allowing for impurities in the second solution.

The vapour pressure of benzene at its boiling point of 81°C is 1 atm. This is due to the fact the definition for boiling point is the temperature at which the vapour pressure of a liquid is equal to the external pressure surrounding the liquid (abouteducation), and the standard ambient external pressure used for determining boiling point is 1 atm.

As there is an increase in atmospheric pressure, the boiling point also increases. Through the ideal gas law: PV=nRT, pressure is directly proportional to temperature.

It is important to have cooling water enter the bottom and not the top of the condenser because this will ensure faster condensation. Heat transfer is dependant on the difference in temperature, therefore the cooler the water is at the bottom the better it is at cooling the vapours. If the cool water was entering through the top, it would have warmed up by the time it got to the bottom. The bottom part is the first part the vapour encounters, so it won't cool down as much, thus having to travel

further up the condenser before condensing. This increases the chances of losing some of the liquid that was being condensed.

Raoult's Law

$PA_0 = 350$ mmHg $\quad T_A = 95°C \quad N_A = 0.75$
$P_A = (PA_0)\ (N_A)$
$= (350)\ (0.75)$
$= 262.5$ mmHg

$PB_0 = 150$ mmHg $\quad T_B = 95°C \quad N_B = 0.25$
$P_B = (PB_0)\ (N_B)$
$= (150)\ (0.25)$
$= 37.5$ mmHg

$P_{Total} = P_A + P_B$
$= 262.5 + 37.5$
$= 300$ mmHg

Therefore the vapour pressure of a 3:1 mixture of compound A and B at 95°C is 300 mmHg.

A simple distillation curve should have more of a gradual increase where the liquid at the beginning of the distillation is enriched in the amount of the lower boiling component and the liquid at the end stages of the distillation is enriched in the higher boiling component. A fractional distillation curve will be more steep than gradual. This is more of an ideal distillation in which the lower boiling component distils completely and then the higher boiling component distils completely. The distillation curves obtained through the experiment somewhat followed this trend. However, the simple distillation curve had a period of decrease. This is not supposed to happen. A source of error in this happening is heat being lost from the heating mantle to the flask. After noticing heat was being lost, tin foil was placed around the mantle to insulate it. After this was done the temperature increased again.

Conclusion:

In conclusion, fractional distillation is a better means of distillation than simple distillation. This is because of the fractional column being used to increase surface area, insulate and create a temperature gradient that will result in a more pure final solution.

References

H. (2016, July 21). Can You Define Boiling Point? Review Your Chemistry Concepts. Retrieved February 07, 2017, from http://chemistry.about.com/od/chemistryglossary/a/boilingpointdef.htm