5: Distillation

Distillation is a purification method for liquids, and can separate components of a mixture if they have significantly different boiling points. In a distillation, a liquid is boiled in the "distilling flask," then the vapors travel to another section of the apparatus where they come into contact with a cool surface. The vapors condense on this cool surface, and the condensed liquid (called the "distillate") drips into a reservoir separated from the original liquid. In the simplest terms, a distillation involves boiling a liquid, then condensing the gas and collecting the liquid elsewhere

5.1: Overview of Distillation

Several distillation variations are used in the organic laboratory depending on the properties of the mixture to be purified.

5.2: Simple Distillation

A simple distillation is used if the components have widely different boiling points (greater than a 100 °C difference in boiling points). However, if a simple distillation is attempted on a mixture where the components have more similar boiling points (less than a 100 °C difference in boiling points), it will fail to purify the mixture completely.

- 5.2A: Uses of Simple Distillation
- 5.2B: Separation Theory
- 5.2C: Step-by-Step Procedures
- 5.2D: Microscale Distillation

5.3: Fractional Distillation

A simple distillation is incapable of significant purification if the boiling points of the components are too close. When the difference in boiling points is less than 100 ˚C, a modification is necessary, namely insertion of a fractionating column between the distilling flask and three-way adapter.

- 5.3A: Theory of Fractional Distillation
- 5.3B: Fractionating Columns
- 5.3C: Uses of Fractional Distillation
- 5.3D: Step-by-Step Procedures for Fractional Distillation

5.4: Vacuum Distillation

Boiling commences when the vapor pressure of a liquid or solution equals the external or applied pressure (often the atmospheric pressure). Thus, if the applied pressure is reduced, the boiling point of the liquid decreases. This behavior occurs because a lower vapor pressure is necessary for boiling, which can be achieved at a lower temperature.

- 5.4A: Overview of Vacuum Distillation
- 5.4B: Predicting the Boiling Temperature
- 5.4C: Step-by-Step Procedures for Vacuum Distillation

5.5: Steam Distillation

Steam distillation is analogous to simple distillation, the main difference being that steam (or water) is used in the distilling flask along with the material to be distilled. Experimentally the setups are arranged more or less the same, with small differences being how the steam is added to the flask: either indirectly if a steam line is available in the building, or directly by boiling water in the flask.

5.6: Rotary Evaporation

The preferred method for solvent removal in the laboratory is by use of a rotary evaporator (also known as a "rotovap"), A rotary evaporator is essentially a reduced pressure distillation: a solution in a round bottomed flask is placed in the water bath of the apparatus, and rotated while the system is partially evacuated (by a water aspirator or vacuum pump). The reduced pressure in the apparatus causes the solvent to boil at a lower temperature than normal.

- 5.5A: Overview of Steam Distillation
- 5.5B: Uses of Steam Distillation
- 5.5C: Separation Theory
- 5.5D: Step-by-Step Procedures for Steam Distillation
- 5.6A: Overview of Rotary Evaporation
- 5.6B: Step-by-Step Procedures for Rotary Evaporation
- 5.6C: Troubleshooting Rotary Evaporation

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