Oxidation of Alcohols

Chemicals and Equipment Needed

- 1-propanol – **R3**
- 2-propanol (isopropanol) – **R3**
- *t*-butanol (2-methyl-2-propanol) – **R1**
- Acidic $K_2Cr_2O_7$ solution – **K3**
  - Recipe follows
- 3 small crystalizing dishes – **P3**
- Plastic petri dishes – **P3**
- 3-10 mL graduated cylinders – **Q3**
- Stoppers for the cylinders (#00)– **U3**
- 3 glass rods – **U1**
- Plexiglass square – **J**
- Transparency from this packet

Hazards

- Alcohols are flammable and volatile solutions. Take care when handling, and pour them in the hood.
- The acidic $K_2Cr_2O_7$ solution is ~2 M H_2SO_4. Wear gloves when handling.

Preparation

- Fill one cylinder with 3 mL 1-propanol, label **1°**. Fill the second with 3 mL 2-propanol, label **2°**. Fill the third with 3 mL *t*-butanol, label **3°**. Stopper all cylinders, and parafilm.
- Add 30 mL $K_2Cr_2O_7$ solution to each crystalizing dish, lid and label.
- On delivery, place the transparency and plexiglass square on the overhead, and the dishes on top (leave the H_2O space blank). Set the cylinders and glass rods next to the overhead.

Presentation

- Add the 1° and 2° alcohols to their respective dishes, then add the 3° alcohol to the proper dish.
  - You may wish to have a student time the reactions.
  - You should see a color change in the 1° and 2° dishes, but the total reaction time is 80 s for the 1° dish and 120 s for the 2° dish. The 3° alcohol does not react.

Discussion

- The 1° alcohol is oxidized to the aldehyde, then to the acid:
  1-propanol → propanal → propionic acid
  [ethanol → ethanol (acetaldehyde) → ethanoic acid (acetic acid)]
- The 2° alcohol is oxidized to the ketone:
  2-propanol → propanone (acetone)
- As the alcohol is oxidized, the dichromate is reduced to Cr(III) ion, which will appear green, blue, or violet in these solutions:
  $Cr_2O_7^{2-}$ (aq) + 14 H^+ (aq) + 6 e^- →2 Cr^{3+} (aq) + 7 H_2O (g)
- The 3° alcohol cannot be oxidized, so it does not react:
  t-butanol → no reaction
- NB: the dichromate oxidation of ethanol is the basis of the breathalyzer test.

Clean-Up

- Combine solutions in a beaker, and neutralize with 6 M NaOH. Pour into white waste container, along with any rinses.

NOTES:

Acidic $K_2Cr_2O_7$ solution: Mix 60 mL concentrated H_2SO_4 with 2.0 g $K_2Cr_2O_7$ (O2), dilute to 500 mL with d-H_2O. Final solution is ~2 M H_2SO_4

Lecturer Instructions

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