Chemistry 1506: Allied Health Chemistry 2

Section 3: Alchols, Phenols, Ethers, and Halides

Functional Groups with Single Bonds to Oxygen

Outline

Section 3.1 Introduction and Nomenclature of Alcohols

- Methanol
  - "Wood alcohol", causes blindness
  - CH_3-OH

- Ethanol
  - Oldest man made chemical (history of agriculture)
  - "Grain alcohol"
  - CH_3-CH_2-OH
  - Made by sugar fermentation with yeast (wine, beer, gasoline)

  - Made industrially by Ethene Hydration (H_2O/H_2SO_4)

- Isopropanol
  - "rubbing alcohol"
  - $(CH_3)_2CH\text{-}OH$

- IUPAC Nomenclature
  - Use anol suffix
  - Number longest chain to include as many OH groups as possible
  - Polyols (diol, triol, tetraol, etc.)
  - Examples

- Alcohol Classification
  - Primary Alcohols, 1°
  - Secondary Alcohols, 2°
  - Tertiary Alcohols, 3°

- Properties
  - Related to Water
  - Intermolecular Hydrogen Bonding
  - Mp and Bp
  - Polar
  - Solubility
  - Biologically Active

Section 3.2 Alcohol Reactions

- Sources of Alcohol Reactivity
  - Bond polarity of R-OH
  - Weak acidity of R-OH

- Dehydration
  - Elimination of water (i.e., H_2O loss)
  - Acid Catalyzed (H_2SO_4 and heat)
  - Generic Reaction

- Zaitsev's Rule
  - Elimination proceeds to give the most substituted alkene
  - Dehydration of 2-butanol

- Oxidation
  - Effects due to class of alcohol
    - 3° vs. 2° vs. 1°
  - Effects due to Oxidizing agent Strength
    - "Generic" Oxidizing Agent, [O]
    - CrO_3 / pyridine (pyr)
      - Chromium trioxide
      - "poisoned" oxidation
    - $K_2Cr_2O_7/H_2SO_4$
      - Potassium Dichromate
      - "full strength" oxidation

- "Weak Oxidation" of 1° Alcohols

- Oxidation of Aldehydes

- "Strong Oxidation of 1° Alcohols

- Oxidation of 2° Alcohols

- Failed Oxidation of 3° Alcohols

Section 3.3 Biological Alcohols

- Glycerol
  - Component of Triglycerides
    - Most common animal and vegetable fats
  - Triol
    - $CH_2(OH)$-$CH(OH)$-$CH_2(OH)$

Section 3.4 Amino Acids having Alcohol Containing Side Chains

- Amino Acids (Building Blocks of Proteins)
  - Generic AA = $H_2N\text{-}CHR\text{-}CO_2H$

- Serine
  - R = $CH_2\text{-}OH$

- Threonine
  - R = $CH(CH_3)\text{-}OH$

Section 3.5 Phenols

- Aromatic Alcohols
  - Originally derived industrially from coal tar
  - Generic Structure (Aromatic-OH)

- Properties
  - Often unpleasant odors
  - Intermolecular Hydrogen Bonding
  - Mp and Bp
  - Solubility
  - Toxicity
  - Acidity (cf. Alcohols)

- Phenol (C_6H_5-OH)

- Cresol (ortho, meta, and para-methyl phenol)

- Many Natural Products
  - Lignins in wood
    - Pulp mill effluent
    - Aerobic oxidation
    - "Trout test"

- Vanillin (1-OH, 2-OCH_3, 4-CHO)

Section 3.6 Amino Acids having Phenol Side Chains

- Amino Acid
  - Generic AA = $H_2N\text{-}CHR\text{-}CO_2H$

- Tyrosine
  - R = $CH_2\text{-}p\text{-}C_6H_4\text{-}OH$

Section 3.7 Ethers

- R-O-R Structure
  - Bond angles ≈ 109.5°

- Physical Properties
  - Mp and Bp vs. Alchols
  - Polarity
  - Hydrogen Bonding (cf. Alcohols and Water)
  - Solubility

- Nomenclature
  - Dialkyl Ether (two words)
  - Alkyl Alkyl' Ether (three words)

- Chemical Reactivity
  - Generally very low
  - Used as Solvents

- Diethyl Ether
  - CH_3-CH_2-O-CH_2-CH_3
  - "ether", "ethyl ether"
  - Anaesthetic
  - Made from grain alcohol and acid

- THF (tetrahydrofuran)
  - Made from Oat husks, Quaker Oat Company
  - Used to make specialty plastics (car dashboards)

- Ethylene Oxide
  - Exceptionally reactive due to ring strain
  - Medical sterilization

- MTBE (methyl tertiarybutyl ether)

Section 3.8 Thiols, Thioethers, and Disulfides

- Cf. Hydrogen Sulfide (H_2S)
- Stink and Toxic

- Thiols (Mercaptans)
  - R-S-H
  - Pentanethiol ($CH_3CH_2CH_2CH_2CH_2$-SH), skunk oil

- Thioethers
  - R-S-R

- Disulfides
  - R-S-S-R

Section 3.9 Amino Acids having Sulfur Containing Side Chains

- Amino Acids (Generic AA = $H_2N\text{-}CHR\text{-}CO_2H$)
- Cysteine (neutral polar)
  - R = $CH_2\text{-}SH$
- Cystine
  - $CH_2\text{-}S\text{-}S\text{-}CH_2$ bridge
- Methionine (non-polar)
  - R = $CH_2CH_2\text{-}S\text{-}CH_3$

Index of Topics and Vocabulary