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19/MHS01/156
CHM102: Assignment

1 $HCOOH$ - Methanoic acid

$HOOCCH_2CH_2CH_2COOH$ - Pentan-1,5-dioic acid

$CH_3CH_2CH_2COOH$ - Butanoic acid

HO_2C-CO_2H - Ethanedioic acid

$CH_3(CH_2)_4COOH$ - Hexanoic acid

$CH_3CH=CHCH_2CH_2COOH$ - Hex-4-enoic acid

2. Physical appearance

All simple aliphatic carboxylic acid up to C_{10} are liquids at room temperature although anhydrous ~~anhydrous~~ carbo most other carboxylic acids are solid at room temp although anhydrous carboxylic acid (acetic acid) also known as glacial ethanoic acid freezes to an ice-like solid below room temperature are

Boiling points

Boiling point increases with increasing relative molecular mass. Aromatic carboxylic acids are crystalline solids and have higher melting points than their aliphatic counterparts of comparable relative molecular mass

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Solubility

Lower molecular mass carboxylic acids with up to four carbon atoms in their molecules are soluble in water; This is largely due to their ability to form hydrogen bonds with water molecules. The water solubility of acids decreases as the relative molecular mass increases because the structure becomes relatively more hydrocarbon in nature and hence covalent. All carboxylic acids are soluble in Organic solvents

Industrial Preparation

Ba From Petroleum

Liquid phase air oxidation of C_5-C_7 alkanes. Obtainable from petroleum at high temperature and pressure will give C_5-C_7 carboxylic acids with methanoic, propanoic and butanedioic acids as by products

$$C_5\text{-}C_7 \xrightarrow[\text{High Pressure}]{O_2 \text{ High Temp.}} C_5\text{-}C_7 \text{ carboxylic acids}$$

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6 From ethanol

Ethanoic acid is obtained commercially by the liquid phase air-oxidation of 5% solution of ethanal to ethanoic acid using Manganese (II) ethanoate catalyst.

Ethanal itself is obtained from ethylene

$$HC \equiv CH \xrightarrow{dil\ H_2SO_4/HgSO_4} CH_3CHO \xrightarrow{O_2/(CH_3COO)_2Mn} CH_3COOH$$

4 Synthetic preparation

Oxidation of primary alcohols and aldehydes can be used to prepare carboxylic acids using the usual oxidizing agents ($K_2Cr_2O_7$ or $KMnO_4$) in acidic solution

$$RCH_2OH \xrightarrow[[O]KMnO_4]{excess\ acid} RCHO \xrightarrow{[O]} RCOOH$$

5 Reduction of Carboxylic acid to Primary alcohol

$$CH_3CH_2CH_2COOH \xrightarrow{LiAlH_4} CH_3CH_2CH_2CH_2OH$$

Butanoic acid — Butanol

b Decarboxylation of Carboxylic acid

$$CH_3CH_2CH_2COONa + NaOH \xrightarrow{Fuse} CH_3CH_2CH_3 + Na_2CO_3$$

Kolbe synthesis

$$2CH_3CH_2COONa + 2H_2O \xrightarrow{\text{Electrolysis/aq}} CH_3(CH_2)_2CH_3 \uparrow_{(Anode)} + 2NaOH + H_{2\,(Cathode)}\uparrow$$

c Esterification

In the presence of strong acid catalyst, Carboxylic acids react with alcohols to form esters

$$CH_3CH_2CH_2COOH + CH_3CH_2CH_2OH \overset{H^+}{\rightleftharpoons} CH_3CH_2CH_2COOCH_2$$

$$CH_3CH_2CH_2COOH$$
$$+$$
$$CH_3\overset{+}{C}H_2CH_2OH$$
$$\updownarrow H^+$$
$$CH_3CH_2CH_2COOCH_2CH_2CH_3$$
$$+$$
$$H_2O$$

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