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19/ENG07/017 Petroleum Engineering
CHM102 Assignment

1. $HCOOH$ - Methanoic Acid
$HOOCCH_2CH_2CH_2COOH$ - Pentan-1,5-dioic acid
$CH_3CH_2CH_2COOH$ - Butanoic acid
H_2OC-CO_2H - Ethanedioic acid
$CH_3(CH_2)_4COOH$ - Hexanoic acid
$CH_3CH=CHCH_2CH_2COOH$ - Hex-4-enoic acid

2. Physical properties of Carboxylic acid under:
Physical appearances:
All simple aliphatic carboxylic acids up to C_{10} are liquid at room temperature. Most other carboxylic acids are solid at room temperature although anhydrous carboxylic acid (acetic acid) also known as glacial ethanoic acid freezes to an ice-like solid below the room temperature

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

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

3. Industrial Preparations
i From carbon(II) oxide: Methanoic acid is manufactured by adding carbon(II) oxide under pressure to hot aqueous solution of sodium hydroxide. The free carboxylic acid is liberated by careful reaction with tetraoxosulphate(VI) acid (H_2SO_4)

$CO + NaOH \longrightarrow HCOONa + H_2SO_4 \longrightarrow HCOOH + NaHSO_4$

ii From petroleum: Liquid phase oxidation of $C_5 - C_7$ alkanes ~~Liquid phase~~ from petroleum at high temperature and pressure will give $C_5 - C_7$ carboxylic acids with methanoic, propanoic ~~acid~~ and butanedioic acids by products

$C_5 - C_7 \xrightarrow{O_2 / \text{High temperature and pressure}} C_5 - C_7$ carboxylic acids

4. i) Oxidation of primary alcohols and aldehydes: Oxidation of primary alcohols and aldehydes can be used to prepare carboxylic acids using the oxidizing agents $K_2Cr_2O_7$ or $KMnO_4$ / acidic solution

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

ii) Carbonation of Grignard reagent: Aliphatic carboxylic acid are obtained by bubbling carbon(IV) oxide into the Grignard reagent and then hydrolyzed with dilute acid

$RMgBr + CO_2(C_2H_5)O \longrightarrow RCOOMgBr \xrightarrow{H_2O / \text{dil acid}} RCOOH + MgBrOH$

R may be $1^0, 2^0, 3^0$ aliphatic alkyl or aryl radical.

5. ~~Chemical equation~~

i) Reduction to Primary alcohol : $4R{-}COOH + 3LiAlH_4 \xrightarrow{(C_2H_5)_2O} 4R{-}CH_2OH + Al(OH)_3 + LiOH$

$CH_3CH_2CH_2COOH \xrightarrow{LiAlH_4} CH_3CH_2CH_2CH_2OH$

Butanoic acid — Butanol

ii) Decarboxylation

$2CH_3CH_2COONa + NaOH \xrightarrow{fuse} CH_3CH_2CH_3 + Na_2CO_3$

iii) Esterification of carboxylic acid

~~$CH_3CH_2CH_2COOH + CH_3CH_2CH_2OH \rightleftharpoons CH_3CH_2CH_2COOH + CH_3CH_2COOH +$~~

$CH_3CH_2CH_2COOH + CH_3CH_2CH_2OH \xrightleftharpoons{H^+} CH_3CH_2CH_2COOCH_2CH_2CH_3 + H_2O$