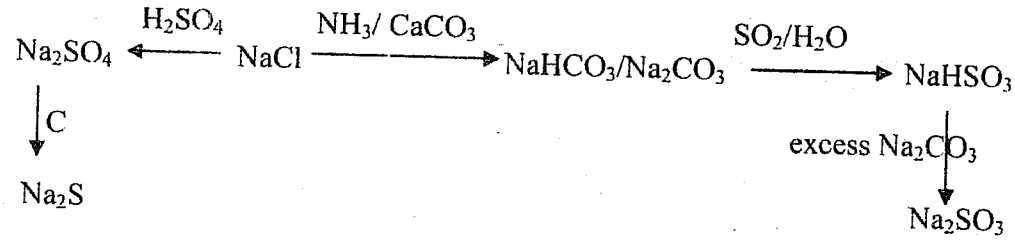
CHU 3237/Industrial Chemistry
Answer Guide for Assignment Test III

1. a) i.



ii. Na_2SO_3/ $NaHSO_3$

$Na_2CO_3 + 2SO_2 + H_2O \longrightarrow 2\ NaHSO_3 + CO_2$
$2\ NaHSO_3 + Na_2CO_3 \longrightarrow 2\ Na_2SO_3 + CO_2 + H_2O$

Na_2S

$2NaCl + H_2SO_4 \longrightarrow Na_2SO_4 + 2HCl$
$Na_2SO_4 + 4C \longrightarrow Na_2S + 4CO$

$NaHSO_3$ – Use to remove excess of free chlorine/ sterilizing agent in beverages
Na_2SO_3 - Used as bleach for wood pulp in the paper making industry/ used to treat boiler feed water / use photographic developer
Na_2S –Use in the paper industry

b) i. Dow process is used to produce magnesia

$Mg^{2+}_{(aq)} + Ca(OH)_{2(aq)} \longrightarrow Mg(OH)_{2(s)} + Ca^{2+}_{(aq)}$
$Mg(OH)_{2(s)} + 2HCl \longrightarrow MgCl_{2(aq)} + 2\ H_2O_{(l)}$

- Cheap lime (dolomitic lime) can be used as raw materiel
- Difficult to sediment ,filter and wash the slimy gelatinous precipitate

Potassium
Seawater is treated with HDPA
$HDPA + K^+ \longrightarrow H^+ + KDPA$
The KDPA (ppt) is separated and treated with an acid
$KDPA + HNO_3 \longrightarrow HDPA + KNO_3$

- The lower concentration of potassium can be selectively extracted from seawater (in the presence of Na^+, Ca^{2+}, Mg^{2+})
- The chelating agent (HDPA) can be recycled to treat fresh brine

c) i. The beaume hydrometer is used widly to determine the relative concentration of the brines in slatterns.
Sea brine that contains about 3.5% dissolved salts gives a reading of 3.5° Be when tested by this hydrometer. The deposition of gypsum begins when relative concentration of the brines in the saltern is between 12° Be -14° Be

Uses of gypsum

- In cement industry
- Use it for agricultural purposes
- Use it to make plaster of Paris

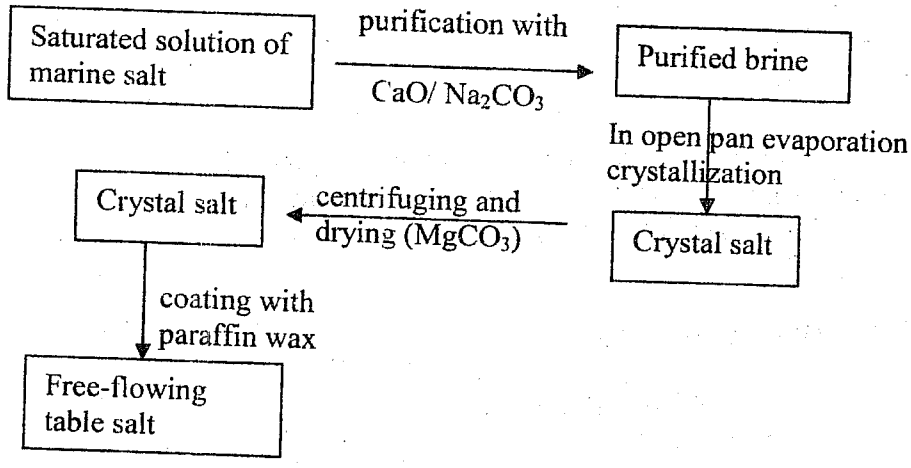
c) ii. Specific gravity $= \frac{144.3}{144.3 - B}$

$= = \frac{144.3}{144.3 - 3.5}$

$= = 1.02$

iii. $2I^-_{(brine)} + Cl_{2(g)} \longrightarrow I_{2(g)} + 2\,Cl^-_{(aq)}$

d)



2. a) i. $2(NaHCO_3.Na_2CO_3.2H_2O) \xrightarrow{\Delta} 3\,Na_2CO_3 + CO_2 + 5\,H_2O$

ii.

- Decomposition
  Lime stone is heated in lime kiln
  $CaCO_{2(s)} \xrightarrow{\Delta} CaO_{(S)} + CO_{2(g)}$
- Ammonia absorption
  Initially NH3 from Haber process, afterwards from recycled gases
- Carbonation
  $CO_{2(g)}$ is absorbed in the ammoniated brine
  $NaCl_{(aq)} + NH_{3(aq)} + CO_{2(g)} -- H_2O_{(l)} \longrightarrow NaHCO_{3(s)} + NH_4Cl_{(aq)}$
- Calcination
  $2NaHCO_{3(s)} \xrightarrow{\Delta} Na_2CO_{3(s)} + CO_{2(g)} + H_2O_{(l)}$
- Ammonia recovery
  $Ca(OH)_2 + 2\,NH_4Cl \longrightarrow CaCl_2 + 2NH_3 + 2H_2O$

b)

Diaphragem cell	Mercury cathode cell
• Steel cathode • H_2 is discharged at the cathode • At the cathode $2 H_2O + 2e \longrightarrow 2 OH + H_2$ • At the anode $2Cl^- + 2e \longrightarrow Cl_2$ • The NaOH drawn off from the cathode compartment contains a large amount of salt • Graphite or titanium coated anode • Anode and cathode compartments are separated by a porous diaphragm • Not economical • Not much environmental consequences	• Mercury cathode • H_2 is discharged at the graphite deunder • At the cathode $Na^+ + e \longrightarrow Na/Hg$ • At the anode $2Cl^- + 2e \longrightarrow Cl_2$ • Pure NaOH can be obtained in a separate vessel • Graphite or titanium coated anode • Anode and cathode are not separated • More economical than the diaphragm cell • Leakage of some mercury can have serious environmental consequences

c) i. Fats and oils refer to compounds of glyceride origin from plants and animals. Fats and oils are mainly tryglycerides and are the esters of the OH groups of glycerol and fatty acids.

(ii) soaps / Cosmetics. Detergents , Alkyd resins for industry , Sulphated oils for industry , Lubricants

(iii) Most fatty acids in nature have an even no. of C atoms, ie C4-----C24. This is because the mode of biosynthesis is by putting together 2C units. Odd chain fatty acids are present only to a small extent.

d. Analysis of oils

Saponification value- No of mg of KOH required to fully saponify 1g of fat/oil under specified conditions. Purity of oil can't be identified by this method.

Iodine value – No. of g of I_2 that react with 100g of oil under specified conditions. Purity of oil can't be identified by this method.

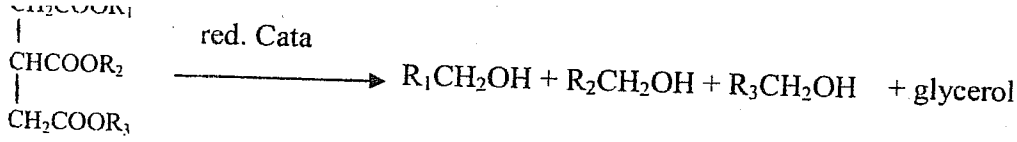
Melting point – the temperature at which melting begins is called the "slip point".
M.P. α 1/ Iodine value and M.P. α chain length. Purity of oil can't be identified by this method.

Refractive Index – The normal range for given oil is found statistically after determining the refractive index in a very large no. of samples of that oil. Purity of oil can't be identified by this method.

Fatty acid composition – This is the ultimate method of verifying the identity of any oil. Here the % w/w of each fatty acid in the oil is determined. F.a. are separated on the basis of their partition coefficient between gas and liquid phases

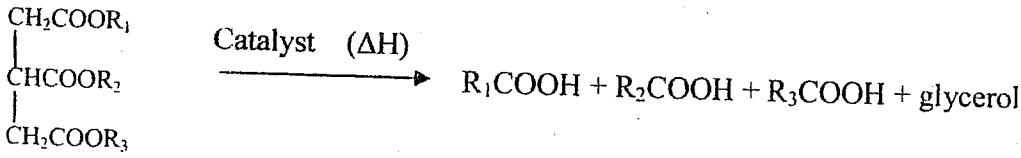
3. a (i) Refer Fig. 2.3, Page 14, unit VI

(ii) Conditions are; Catalytic chamber, Catalyst 0.2-1 % w/w Ni per 100g oil, Temperature 180-200°C, H_2 pressure 2-4 $kgcm^{-2}$, Purpose; to increase its melting point to form a fat



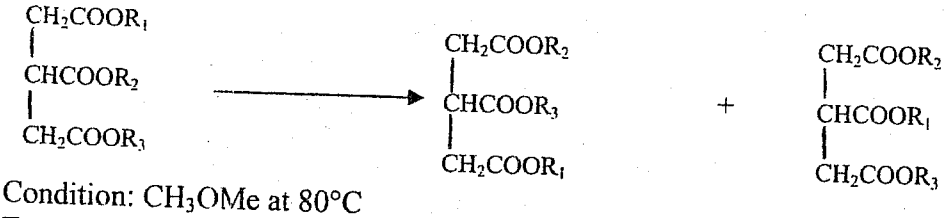
Catalyst: C_2H_5OH /Na or H_2/Ni

Splitting



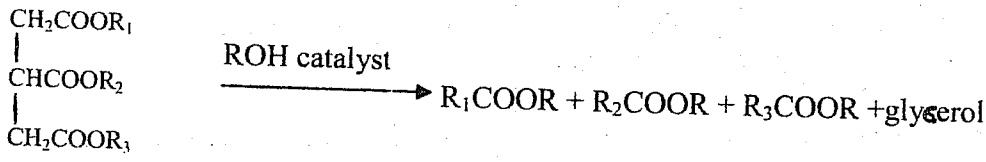
Condition: 100°C, 24-48 h, cat. Alkylated benzene or 250-270°C, 500-725 psi with a catal oxides of Zn, Mg or Ca) or 260°C, 55bar, steam-no catalyst

Intersterification

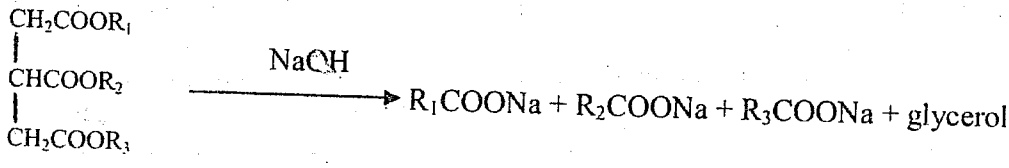


Condition: CH_3OMe at 80°C

Transesterification

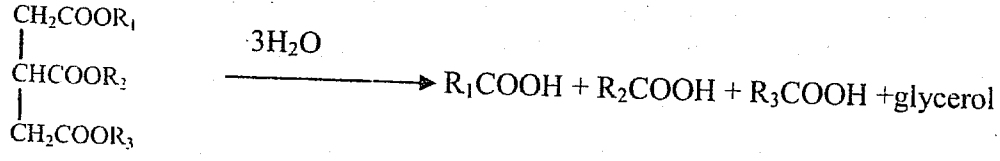


Saponification



c) There are 3 processes of soap manufacturing. Cold process, semi-boiled process and full-bo process. In soap manufacturing fatty acids and NaOH or KOH are used as raw materials. Bu detergent manufacturing other than them strong cationic or strong anionic compounds are al used.

d) i. Splitting of fats



Conditions: 100°C with long chain alkyl benzene sulphonate as catalyst or 250-270°C at 500 psi pressure

ii. Products are glycerol and fatty acids