THE OPEN UNIVERSITY OF SRI LANKA
B.Sc/ B.Ed DEGREE PROGRAMME- 2008/2009
Level 5- CHU 3237/ CHE 5237

INDUSTRIAL CHEMISTRY

ASSIGNMENT III TEST (NBT)

Date: Saturday 4th April 2009 Time: 1.30 p.m.- 3.00 p.m.

Answer all the questions.

1. (a)(i) Explain the essential difference between a fat and an oil.
(ii) Write four uses of fats and oils in chemical industry.
(iii) Give five examples of fats and oils derived from vegetable sources.
(30 marks)

(b)(i) Draw the full structure of the fatty acid, C18:2 Δ 9c, 12c. Write the IUPAC name.
(20 marks)

(c) Draw the flow chart for the extraction of coconut oil from copra, indicating the important steps in it. (15 marks)

(d)(i) Define the terms, saponification value and iodine number. Write the significance of these terms.
Castor oil is a mixture of triglycerides, having about 90% of its fatty acid content as the unsaturated hydroxy aliphatic acid, ricinoleic acid,

$CH_3(CH_2)_5CH(OH)CH_2CH=CH(CH_2)_7COOH$

Estimate the saponification value and iodine number of castor oil.
(C= 12, H= 1, O= 16, K= 39, I= 127) (35 marks)

2. (a)(i) What are detergents? How do they compare with soap?
(ii) Compare the methods of manufacture of soap and detergents. (30 marks)

(b)(i) Briefly describe, using an example in each case, the processes "splitting", "reduction" and "transesterification" of fats and oils.
(ii) Give an important use of each of these processes. (30 marks)

(c) What is the major product of each of the following reactions?

(i) $CH_4 + H_2O \underset{\text{steam reforming}}{\overset{\text{Ni}}{\rightleftharpoons}} A$

(ii) $NH_3 \xrightarrow[\text{Pt - Re / 900°C}]{O_2 / H_2O} B$

(iii) $CH_3{-}CH{=}CH_2 \xrightarrow[\text{solid acid catalyst}]{H_2O\ (\text{steam}) / H^+} C$

(vi) $CH_2{=}CH_2 \xrightarrow[2)\ 500°C]{1)\ Cl_2 / FeCl_3} D$

(v) $O_2N{-}C_6H_4{-}NH_2 \xrightarrow[2)\ C_6H_4(C_2H_5)N(CH_2CH_2OH)]{1)\ NaNO_2 / HCl / 0°C} E$

(30 marks)

(d) Briefly describe the following terms.

(i) Naphtha. (ii) Octane number. (iii) Mordant dye
(iv) Auxochrome (v) Vat dying (30 marks)

3. (a)(i) Distinguish between 'cracking' and 'reforming'.
(ii) Write reasons for carrying out cracking and reforming petroleum.
(iii) Differentiate between catalytic cracking and thermal cracking.
(iv) List the two main purposes of carrying out thermal cracking. Briefly explain how catalytic cracking is carried out.
(v) Write down the factors affecting the rate and efficiency of catalytic reforming.
(80 marks)

(b)(i) List the two components of the original Ziegler-Natta catalyst, used to make high density polyethylene.
(ii) What is "Visbreaking"? What is the purpose of it? (30 marks)

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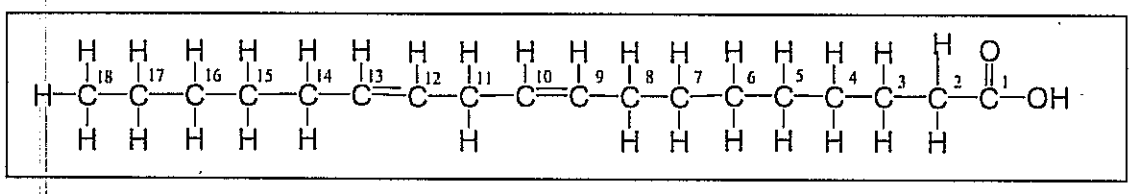
INDUSTRIAL CHEMINSTRY – 2008/ 2009 NBT (III) – Answers

1. (a) (i) Oil is a liquid at room temperature.
Fat is a solid or semi- solid at room temperature.

(ii) Soaps industry
Detergents
Alkyd resins
Sulphated oils
Lubricant
Cosmetic industry…….. etc

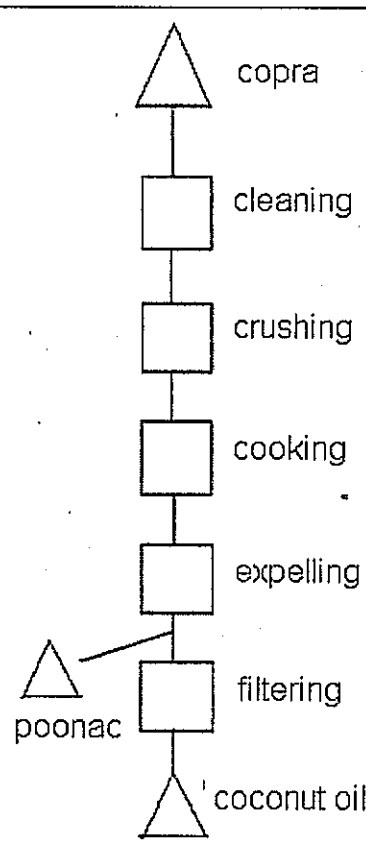
(iii) Soybean oil
Palm oil
Coconut oil
Linseed oil…… etc

(b)



Cis-9,12-octadecadienoic acid
Or
Cis-9-cis-12-octadecadienoic acid
or
Octadecacis-9-cis-12-dienoic acid

(c)



(d)

Saponification value – The saponification value of a fat is identified as the number of milligrams KOH required to fully saponify 1 gram of fat/ oil sample under specified conditions.

Iodine number – iodine number is defined as the number of grams of iodine that react with 100g of oil under specified condition.

Significance

- Saponification value – means chain length.
- Iodine number – means number of double bands.

Saponification value

MW of ricinoleic acid = 932

932g glyceide requires = 3 x 56g KOH

1g requires = $\frac{3 \times 56 \times 1000\text{mg KOH}}{932}$

= 180.25 mg

= 180 mg

Iodine value

Total # double bands per mole = 3

Iodine value = $\frac{2 \times 127 \times 3}{932} \times 100$

= 2 x 40.88 g

= 81.76

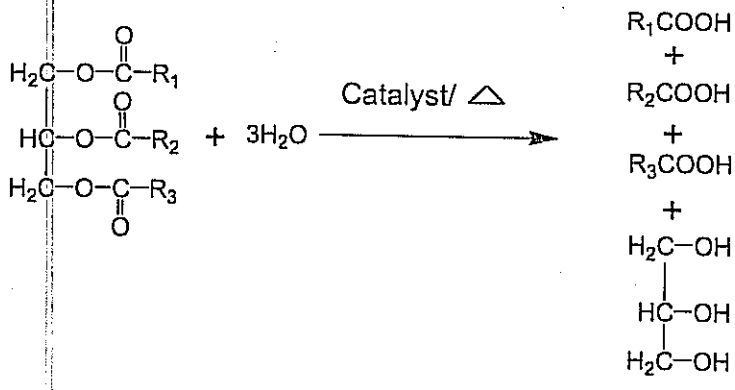
2. (a) (i) Detergents are cleansing agents, which action is similar to the soap. Detergent consists of a long hydrocarbon chain and a water soluble ionic group / polar group.
Detergent has a wider range of application and efficiency than the soap.
[Detergent does not react as readily with hard water.]

(ii)

Soaps	Detergents
• Fat and oils are only sources • Produce from saponification of fat / oil • There are 3 processes cold, semi – boiled and fully boiled.	• Petroleum and fat / oil are sources. • Produce from reduction of fat / oil.

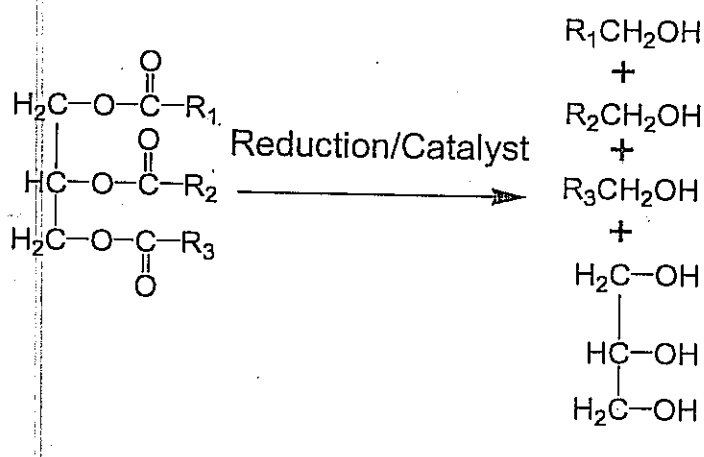
(b) Splitting

Splitting of triglycerides under the influence of catalysts yields fatty acids and glycerol.



Reduction

This is fat / oil splitting under reducting conditions.



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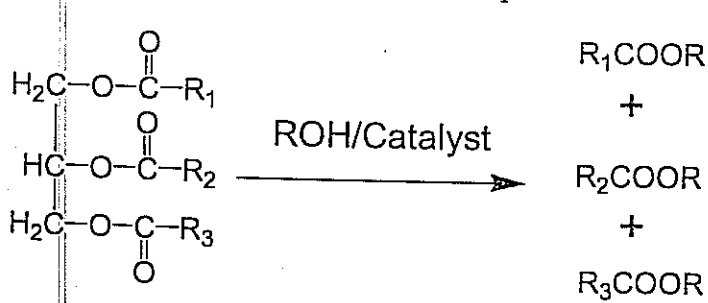
Transesterification

Fat / oil are treated with an alcohol in the presence of catalysts.

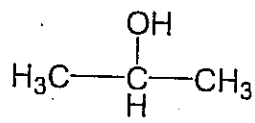


(ii) Splitting – for Oleo chemical industry.
Reduction – for the manufacture of detergent.
Transesterification – for manufacture of chemicals OR diesel oil extender.

(c) (i) A - $CO + 3H_2$

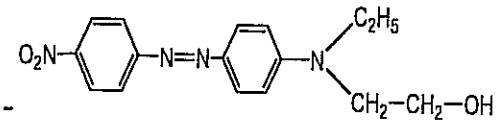
(ii) B - $HNO_3 + NO$

(iii) C



(iv) D – $CH_2 = CHCl$

(v) E -



(d) (i) Naphtha

Aromatics are sometimes called Naphtha. Naphtha is a term whose usage is varied. It ca mean different groups of compounds. Often it is used for aromatics and their substitute mixtures containing benzene , toluene , xylene, and C_9 – aromatics, Naphtha in th petrochemical industry can mean any chemical seeds took with a boiling point from 70 200°C.

(ii) Octane number

The octane number is a measurement of quality of fuel. The higher the octane numbers th lower the tendency of a fuel to knock in the engine which is an arbitrary scale. From 0 to 10(n – Heptanes "knocks" considerably and has an octane rating of zero, and isooctane has 100 Catalytic reforming is process to increase octane number.

(iii) Mordant dye

Without the mordant the dye will not binds as it has no affinity to the fiber. Therefore mordant has to be treated before the dye can be applied. (Give examples)

(iv) Auxochromes

The intensity of colour depends on other group's pressure on organic compounds with Chromophore. Generally, Auxochromes contains less pairs of electrons.
eg: $-NH_2$, -NHR , $-NR_2$, -OH

(v) Vat drying

These are dyes that cannot bind the fabric while they are in the colored oxidized form. They must be reduced to a soluble form first. Ten the fabric is soaked in the reduced dye in a vat (tank). The soaked fabric is then exposed to O_2 / air to produce the colour.
eg: indigo dye
Anthroquinone dye

3) a)

(i) Cracking means breaking up large molecules into smaller ones.
Reforming is the conversion of alkanes and cycloalkanes to aromatics in order to increase the octane number of a gasoline.

(ii) Cracking

- To increase the volume of fuel
- To increase petrochemical feedstock fraction

Reforming

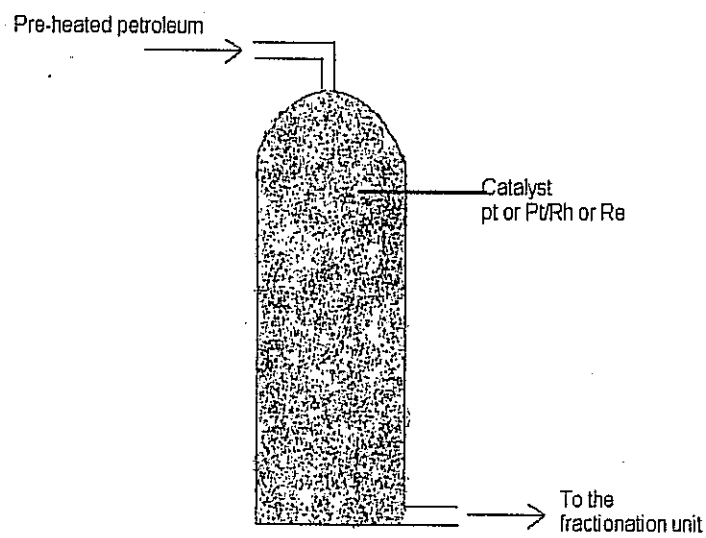
- To boost/increase octane number

(iii)In the thermal cracking process using heat to break up large molecules,but in the catalytic cracking process using the catalyst.

(iv)Thermal cracking

- Viscosity breaking/ visbreaking
- Coking

The pre-heated petroleum feed is forced up a column like reactor contain powdered catalyst. The products passing out at the top of the column are collected and fractionated.



(v)

- Temperature
- Pressure
- Catalyst used
- Aromatic content of feedstock

b)

(i) $(C_2H_5)_3Al + TiCl_4$

(ii) Visbreaking is a mild thermal process done for the several possible purposes

- Reduction of fuel oil production
- Production of lighter distillates
- Production f feedstock for catalytic cracking