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

INDUSTRIAL CHEMISTRY

ASSIGNMENT II TEST (NBT)

Date: Friday 13th March 2009 Time: 4.00- 5.30 p.m.

*Answer any **three** of the following questions.*

1. (a)(i) Write all the ingredient used in the manufacture of soda glass and briefly explain the role of each of them.
(ii) As you know viscosity is the most important physical property of glass melt in the manufacturing process. Briefly describe the variation of viscosity with temperature for soda lime silicate glass and write the significance of the 'working range'.
(iii) What is meant by 'glass transition temperature' (T_g)? (40 marks)

(b) In glass industry, different processes are used to produce different products: Casting, floating and blowing are some of the processes used. Write down the product(s) of these processes. (15 marks)

(c) The composition of ordinary glass is modified by adding various oxides to the glass body mixture for different applications. (30 marks)

Oxide(s)	Useful property	Application
B_2O_3	.....	.....
Pb oxide	.....	.....
Cu and Ag oxide	.....	.....

(d) What colour will be imparted when we use compounds of the following metal ions as the glaze?
Co .....
Se .....
Cr ..... (15 marks)

2. (a)(i) Distinguish between the terms, mortar and concrete.
(ii) Write the major crystalline phases present in Portland cement clinker.
(iii) Distinguish between: (α) 'setting' and hardening' (β) 'flash set' and 'false set'.

(iv) If you are supplied with the following raw materials (% moisture content), what would be your choice of the process for the manufacture of Portland cement? Give reason(s) for your answer:
(α) chalk, clay (30%) (β) limestone, slate (12%) (60 marks)

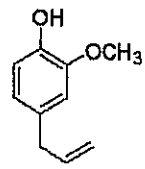
(b)(i) Draw the flow chart for the dry process for the manufacture of Portland cement. (20 marks)

(c) Write the reactions taking place in the kiln between 500°-1300°C during burning in the production of Portland cement clinker. (20 marks)

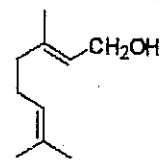
3. (a)(i) What do you mean by 'hydraulic cement'?
(ii) Briefly describe the changes that take place when the phase C_3S phase undergoes hydration. Comment on the rates of hydration of the phases present in Portland cement clinker. (30 marks)

(b) Describe, identifying the instrument used in each case, the standard tests available for cement paste. (20 marks)

(c)(i) What is an essential oil?
(ii) Explain, giving relevant equations, how eugenol is isolated from cinnamon leaf oil.
(iii) Briefly describe the method of determination of percentage of volatile (light) oil in a spice.
(iv) Explain how you would determine the percentage of Geraniol in citronella oil using chemical methods. Discuss the limitations.



eugenol



geraniol

(50 marks)

4. (a)(i) What do you mean by pungency?
(ii) Write the major components of essential oils derived from the following species
Cinnamon bark ..... Clove .....
Lemon grass ..... Ginger .....
(30 marks)

(b)(i) Categorize rosin and turpentine chemically.
(iv) Draw and label a simple flow diagram to show the production of rosin and turpentine from purified pine oleoresin. (30 marks)

(c)(i) What is the difference between spice oleoresin and spice oil?
(ii) What is meant by the term 'value addition' to spices? Explain how value addition can be applied to pepper and clove. (40 marks)

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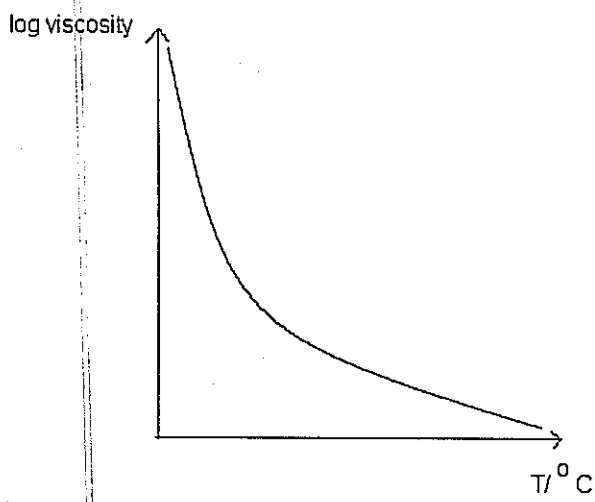
INDUSRIAL CHEMISTRY

ASSIGNMENT TEST (II)- Answers

1. (a)

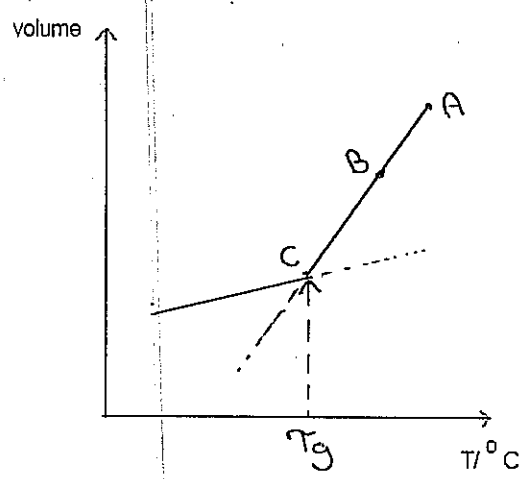
i. Silica(main ingredient)- melts when heated and when cooled becomes transparent glass
Fluxes (oxides such as Na_2O,K_2O,MgO..etc) - lower the temperature at which silica melts.
Stabilizes- $CaCO_3$ (limestone) - to overcome solubility of water glass.

ii. As the temperature increases, the glass mixture begins to melt; viscosity decreases as given below:



When the viscosity is high, the liquid will flow slowly; liquids with low viscosity will flow easily. There is a specific viscosity range (corresponding to a sp. temp range) in which glass making techniques can be carried out this viscosity range is called 'working range'.

(iii)



When glass liquid is cooled, volume decreases (AB) and reaches the melting point at which if the cooling is rapid, crystallization will not take place. The volume will decreases almost at the same rate as before (BE) and continue till Tg. Beyond Tg the slope of the line decreases (lower volume expansion coefficient). Glass begins to form at Tg (glass transition coefficient). Below tg, the material is glass.

(b)Casting – cups
Floating – flat surfaces (glass sheets)
Blowing – flask, vase

(c)B_2O_3 -low coefficient of expansion -Ovenware, chemical lab ware
-Withstand high T
-less prone to chemical attack
Pb oxide -high refractive index /brilliance -Cristal glass were
Cu & Ag oxide- Electronic property -Photochromic glass

(d)Co – blue
Se – red
Cr – green

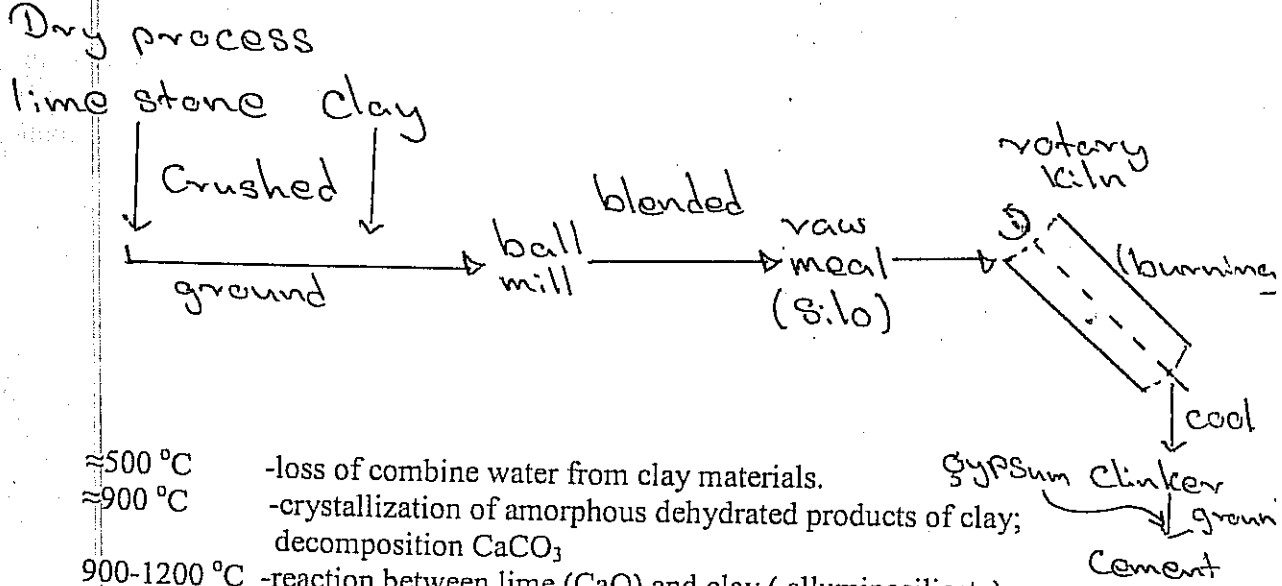
2. (a)
i. Motor - cement + sand
Concrete- cement + sand + stone

ii. C_2S, C_3S, C_3A, C_4AF

iii. (α) Setting – stiffening of the cement paste; setting refers to a change from fluid to a rigid state.
Hardening – refers to gaining of strength of a set cement paste.
(β)Flash set – immediate stiffening of the cement paste.
False set – abnormal premature stiffening of cement within a few minutes of mixing with works (No appreciable heat is evolved).

iv. (α) Chalk, clay (30%)- wet process since closer to35-50% water content (for slurry)
(β) lime stone, slate(12%)- semi dry process, closer to 10 to 15% water (for pellets)

(b)



(c) ≈500 °C -loss of combine water from clay materials.
≈900 °C -crystallization of amorphous dehydrated products of clay; decomposition $CaCO_3$
900-1200 °C -reaction between lime (CaO) and clay (alluminosilicate)
1250-1280 °C- beginning of liquid formation.
>1280 °C- further formation of liquid and completion of formation of cement compound.

3) (a)

(i) Hydraulic cement- The cement that has the property of setting and hardening under water because of hydration.

(ii) The reaction of C_3S begin by resolution of surface C_3S in water. The product has low solubility and form a semi permeable membrane or C_3S.The reaction of C_3S slows down (because of the surface of C_3S begir covered by reaction product).Ca^{2+} ion diffuse out from the C_3S through this semi permeable membrane into water.H_2O and H_3O^+ from water pass through this membrane towards solid surface of C_3S. Diffusion of ions through the membrane causes an increase in the osmotic pressure and this leads to rupture of coating. Finally another CSH gel forms. When the membrane ruptures, silicate ions trapped by membrane are released; they repeat with Ca^{2+} which water to form tubular fibrils.

Rate of hydration: $C_3A > C_4AF = C_3S > C_2S$

Or

$C_3A > C_4AF = C_3S > C_2S$

(b) Plasticity – vicat apparatus / needle

Plasticity is defined by its normal consistency and its initial and final set.

A paste is made from cement and a defined amount of water and it placed in the vicat apparatus, which measures the depth of penetration of a 1 mm diameter needle into cement paste under a 300g load. Initial set penetration is taken when the paste has started to stiffen and final set is when paste has hardened sufficiently to sustain a load.

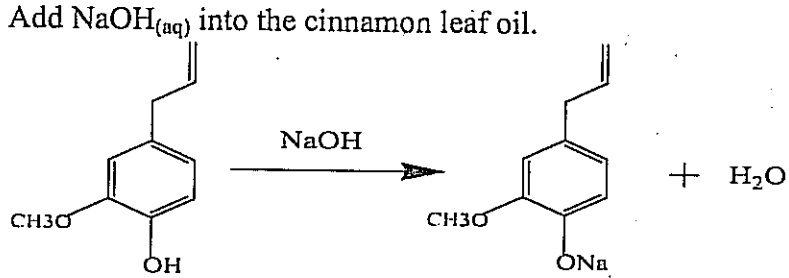
Unsoundness- le Chatelier apparatus

Cement has said to be unsound when the hardened cement paste is accompanied by expansion causing cracking and reduction in strength. Unsoundness refers to the expansion of the cement after final set.

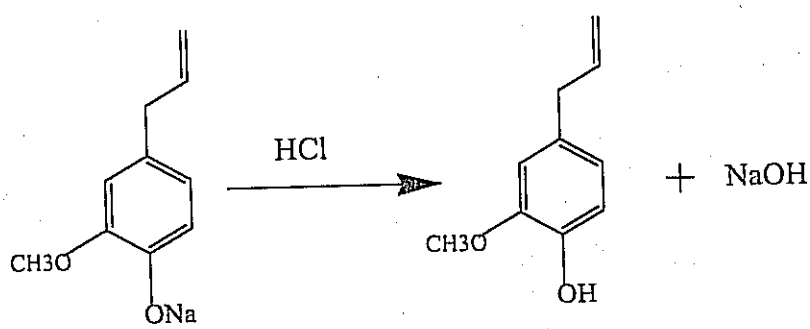
(c) (i) An essential oil is a steam volatile distillate of a plant. Which contain 200-300 components of terpenoids with usually one of them dominating.

(ii)

- Add $NaOH_{(aq)}$ into the cinnamon leaf oil.



- Then sodium Eugenate will go to the aqueous layer.
- Separate aqueous layer and add $HCl_{(aq)}$ into the aqueous layer.

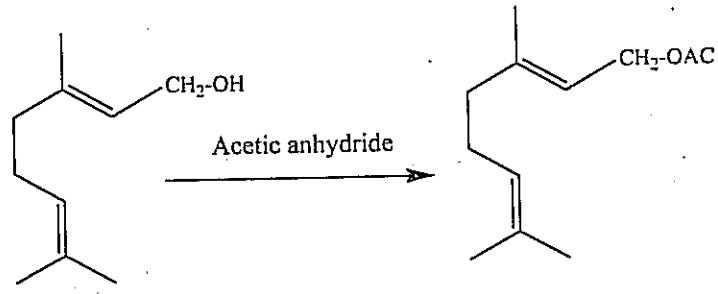


- Separate eugenol from aqueous layer.
- The eugenol can be steam distilled and about 98-99% pure eugenol isolated.

(iii)

- The percentage of light volatile oil in a spice is usually measuring by water distillation using a Clevenger arm.
- Clevenger arm traps light oils after distillation.
- Since the weight of spice is known and the volume of volatile measured.
- The % volatile oil v/w can be calculated.

(iv) This is determined by % acetyl sables by treatment of the volatile il of citronella with acetic anhydride.



Limitation

- Citronella oil contains hydroxyl group present compound than geraniol. eg citronellol, borneol

- Aldehydes can be reacting with acetic anhydrides.

4. (a) (i) Components that give a hot burning sensation when introduced into the mouth or on to the skin.

(ii)Cinnamon bark- Cinnamaldehyde
Clove - Eugenol
Lemon grass - Citral
Ginger - Zingiberene

(b) (i)Rosin - Diterpene
Turpentine- Mono and Sesquiterpenes
(ii)Look book vi

(c) (i) Spice oil – It's only contain volatile active principles.
Spice oleoresin- It's contain volatile and non-volatile active principles.
(ii) Producing Oleoresins

Value addition
(A) Pepper
- Removal of black pigment
- Maintaining natural green

(B) Clove
Pure eugenol isolating from essential oil.