Calculate the standard heat of reaction ΔH_r of the following: 5

$C_2H_5OH(1) + CH_3COOH(1) = C_2H_5OOCCH_3(1) + H_2O(1)$

Heats of combustion are as follows:

C_2H_5OH	$\Delta H_c = -326{,}700$ cal
CH_3COOH	$\Delta H_c = -208{,}340$ cal
$C_2H_5OOCCH_3$	$\Delta H_c = -538{,}760$ cal

arbon monoxide at 200° C is burned under atmospheric pressure with dry 10
r at 500° C in 90% excess of that theoretically required. The products of
mbustion leave the reaction chamber at 1000° C. Calculate the heat
olved in the reaction chamber in kilo calories per kilogram mole of CO
rned assuming complete combustion. (The mean specific hear of CO, air,
O_2, O_2 and N_2 are 7.017, 7.225, 11.92, 7.941 and 7.507 kcal/kg-moles
spectively.)

moles of liquid air is stored in a vessel at atmospheric pressure. Heat 7
ks through the vessel walls so that vaporization occurs. Under these
ditions the relative volatility of N_2 to O_2 may be taken as constant at 2:1.
culate the moles of liquid left in the vessel, when the residual liquid
mposition is 50 mole % nitrogen and 50 mole % oxygen.

en 1.0g of naphthalene ($C_{10}H_8$) is burned in an oxygen-bomb 8
rimeter, with all water formed during the combustion of the naphthalene
g condensed, 40.28 kJ are evolved at 25° C. Calculate the gross heating
e and the net heating value of naphthalene at constant pressure and 25°
he latent heat of vaporization of water at 25° C is 44.05 kJ/g-mole.

2015

Mechanical Operations
(CHEN 2101)

Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

Choose the correct alternatives for the following: 10 x 1=10

Ultrafine screening refers to screening a feed of size-range
(a) above 4 mesh (b) 4 mesh-48 mesh
(c) below 48 mesh (d) none of these.

The value of sphericity for cube is
(a) 2 (b) 1 (c) 1.75 (d) 0.65.

Mid energy mill is a
(a) Crusher (b) Grinder
(c) Ultrafine grinder (d) None of these.

Angle of nip is inherent with
(a) Toothed roll crushers (b) Impactors
(c) Smooth roll crushers (d) None of these.

Sedimentor is called clarifier when the desired product is
(a) Concentrated sludge (b) Suspended slurry
(c) Clear liquid (d) Both a and b.

Which law is more applicable for fine grinding?
(a) Rittinger's law (b) Kick's law
(c) Bond's law (d) All of these.

In connection with froth floatation, pine oil is a
(a) Frother (b) Modifier
(c) Collector (d) None of these.

What is the unit of filter medium resistance?
(a) m (b) m^{-1} (c) m^{-2} (d) None of these

(ix) Effect of system geometry in agitated vessels is expressed in the form of
(a) Power number (b) Flow number
(c) Shape factors (d) Froude number.

(x) For laminar flow of filtrate through the cake deposited on septum, which following will be valid?
(a) Kozeny- Carman equation (b) Ergun equation
(c) Burke Plummer equation (d) None of these.

Group – B

2.(a) Define mesh number. What are the utilities of screening? Name three di standard sets of screens.

(b) Calculate the volume surface mean diameter for the following particulate so

Size of screen opening (μ)	-704+352	-352+176	-176+88	-88+44	Pan
Mass of particle in range (g)	25	37.5	62.5	75	50

(1+2+3)+6

3.(a) For transportation of hot, lumpy materials which type of conveyor is prefer Explain the action of a screw conveyor with a neat diagram.

(c) What are the advantages of pneumatic conveyors over mechanical conve Explain the working principle of a dilute phase pressure system with a diagram.

(1+5) + (2+4)

Group – C

4.(a) A material is crushed in a jaw crusher and the average size of the partic reduced from 5 cm to 1 cm with energy consumption of 1.32×10^4 J/kg. What be the consumption of energy to crush the same material from 7.5 cm to 2.5 assuming i) Rittinger's law ii) Kick's law?

(b) Differentiate between open-circuit and closed-circuit grinding operation wi diagram. Define work index.

(3+3) + (4+2)

5.(a) In a ball mill of 2000 mm diameter, 100 mm steel balls are being used crushing. Presently the mill runs at 15 rpm. At what speed will the mill hav run if 100 mm balls are replaced by 50 mm balls, all other conditions remai same?

) Explain the principle of action of a fluid energy mill with a neat diagram. (6) + (4+2) = 12

Group – D

) Differentiate between free and hindered settling. Explain the operation of an elutriator with a neat diagram.

) A hydraulic classifier is being used for the separation of quartz particles from galena particles under free settling conditions. The specific gravities of quartz and galena are 2.65 and 7.5 respectively. The original mixture has a size range from 0.00052 to 0.0025 cm. Three fractions – pure quartz, pure galena and a mixed fraction – are obtained. What are the size ranges of the two materials in the mixed fraction? (2+4) + 6 = 12

) What are the different methods of preventing vortex formation during agitation operation. With respect to flow-patterns, what are the different types of impellers? Give examples of each type.

) A pilot plant vessel (305 mm) is agitated by a 6 blade turbine impeller 102 mm diameter. When the Reynolds number is 10^4, blending time of two miscible liquids is 15 s. The power required is 0.4 kw/m³ of liquid. What power input will be required to give same blending time in a 1830 mm vessel? (3+3) + 6 = 12

Group – E

) What are the driving forces of filtration?

) What are the main objectives of filter aid and washing of filter cake?

) What is the main difference between compressible and incompressible cakes?

) Discuss the principle and operation of a rotary drum vacuum filter with the help of a neat diagram. 2 + 3 + 2 + 5 = 12

(a) Derive the total pressure drop equation over the incompressible filter cakes.(where A, μ, α, ΔP, R_m, c, t, V have their usual meaning)

) The following relation between α and ΔP for superlight $CaCO_3$ has been determined :
$\alpha = 7.8\times10^{10}[1+4.36\times10^{-4}(\Delta P)^{0.86}]$, where ΔP is in kg/m².

A slurry of this material giving 1.5 kg of cake solid/m³ of filtrate is to be filte
a constant pressure drop of 50 kg/cm² and a temperature of 20°C. Experime
this sludge and the filter cloth to be used gave a value of
$R_m = 1.2 \times 10^{10}$ m^{-1}.
A plate and frame filter is to be used. Calculate the total no of frames requi
give 2000 lit of filtrate in 1 hr. The viscosity of the water at 20°C is 1 cp and
of one frame is 300 cm².

6 + 6

2015

Fluid Mechanics
(CHEN 2102)

Allotted : 3 hrs Full Marks : 70

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

didates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

10 x 1=10

Choose the correct alternatives for the following:

i) The ratio of inertial forces to gravitational forces is called ---------- number
(a) Froude (b) Euler (c) Reynolds (d) Mach.

ii) The ---------- is measured by piezometric opening.
(a) Dynamic pressure (b) Static pressure
(c) Total pressure (d) Point pressure

iii) For an ideal fluid the Reynolds number is
(a) infinity (b) zero (c) one (d) 2100.

iv) For turbulent flow of the Newtonian fluid in a circular cross-section pipe, the ratio of maximum to average fluid velocity is
(a) 0.5 (b) 1 (c) 0.66 (d) < 0.5.

v) The velocity profile for a Bingham plastic fluid flowing in laminar conditions in a pipe is
(a) Flat (b) Parabolic
(c) Flat near the wall and parabolic in the middle
(d) Parabolic near the wall and flat in the middle.

vi) The operation of a venturimeter is based on
(a) Variable flow area (b) Pressure at a stagnation point
(c) Pressure drop across a nozzle (d) None of the above.

vii) The average velocity during pressure driven laminar flow through a rectangular channel is
(a) ½ maximum velocity (b) 2/3 maximum velocity
(c) 1/3 maximum velocity (d) ¼ maximum velocity.