GIET MAIN CAMPUS AUTONOMOUS,
GUNUPUR - 765022

Registration No: | | | | | | | | | | |

Total Number of Pages :3

B.TECH. DEGREE EXAMINATION-Nov-Dec.2018
End Semester Examination-III Semester
BCHPC3020-MECHANICAL OPERATIONS
(Regulations 2017)(Chemical Engineering)

Time : 3 Hours Maximum : 100 Marks Question Code:31312

Answer ALL Questions

PART-A (10 X 2=20 Marks)

1. a) The critical speed of a ball mill of radius 'R', containing balls of radius 'r', is proportional to: [CO1][PO2]
(a)$(R-r)^{0.5}$ (b) (R-r) (c) $(R-r)^2$ (d) $(R-r)^{-0.5}$

b) Sphericity of a cylindrical particle having length equals to diameter is: [CO1][PO2]
(a)1.5 (b) 0.5 (c)1.0 (d) 0.67

c) For the Tyler standard screen series, when the mesh no. increases from 3 mesh to 10 mesh, then: [CO2][PO1]
(a)Clear opening decreases (b)Clear opening Increases
(c)Clear opening remains unchanged (d)Wire diameter increases

d) Trommels separate a mixture of particles depending on their: [CO2][PO1]
(a)Density (b)Size (c)Wettability (d)Electrical and magnetic properties

e) With increase in the capacity of screen, the screen effectiveness: [CO2][PO1]
(a)Remain unchanged (b)Increases (c)Decreases (d)Increases exponentially

f) The dimensions of filter medium resistance in cake filtration is: [CO3][PO1]
(a)$M^0L^{-1}T^0$ (b)$M^1L^{-1}T^0$ (c) $M^0L^1T^{-1}$ (d) $M^{-1}L^0T^0$

g) For a cyclone of diameter 0.5m with tangential velocity of 20 m/s at the wall, the separation factor is (Taking g = $10m/s^2$): [CO3][PO2]
(a)120 (b)130 (c)160 (d)100

h) For an impellor of diameter 'D', at very low rpm (Reynolds No. <5), the power required for agitation is proportional to: [CO3][PO1]
(a)D (b)D^2 (c)D^3 (d) D^5

i) In froth floatation, chemical agent added to cause air adherence is called: [CO4][PO1]
(a) Collector (b) Frothier (c) Modifier (d) Activator

j) Traces of solids are removed from liquid in a: [CO4][PO1]
(a)Classifier (b) Clarifier (c)Sparkler filter (d) Rotary vacuum filter

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PART-B (10 X 2=20 Marks)

2.	a)	Define '*Work Index*' for Bond's Law of grinding?	[CO1][PO1]
	b)	Define '*Reduction Ratio*' for any grinding equipment?	[CO1][PO1]
	c)	Show graphically relation between efficiency of screen and feed rate?	[CO2][PO1]
	d)	What is the critical rotation speed in rev/sec for a ball mill of diameter 1.2m and charged with 70mm diameter balls? (Take, g = 9.81 m/s^2)	[CO2][PO2]
	e)	Sticky materials are transported by which type of conveyors?	[CO2][PO1]
	f)	What is the terminal velocity in m/s calculated from Stoke's Law for a particle of diameter $0.1*10^{-3}$ m, density 2800 Kg/m^3, settling in water of density 1000 Kg/m^3 and viscosity 10^{-3} Kg/(m.s) ? (Assume, g = $10m/s^2$)	[CO3][PO2]
	g)	Write the principle of separation in *sink and float* method and also mention one of the industrial application of this method?	[CO3][PO1]
	h)	Show the different forces acting on a spherical ball moving downwards in the fluid and also state the condition in terms of force balance when it will attain terminal settling velocity?	[CO3][PO1]
	i)	Give an example of each *Leaf filter* and *continuous vacuum filter*?	[CO4][PO1]
	j)	Name two different types of impellers on the basis of flow currents generated by them?	[CO4][PO1]

PART-C (4 X 15=60 Marks)

3a.	i.	If crushing rolls, 1m in diameter are set so that the angle of nip is 31°. Find the distance between crushing surfaces so that the radius of maximum size of particles fed to the rolls is 25mm. If the actual capacity of machine is 12% of theoretical capacity. Calculate the throughput in Kg/s, when running at 2.0 Hz if the working face of rolls is 0.4m long and bulk density of feed is 2500 Kg/m^3.	[10][CO1][PO2]
	ii.	Describe in detail about the two principle types of *pneumatic conveying* systems? Also write few advantages of *wet grinding*?	[5][CO1][PO1]
		(or)	
b.	i.	A limestone sample having average particle size 50 mm is crushed in a Blake jaw crusher to get the average product size as 10 mm and energy consumed in crushing is 13 KW/(Kg/s). What would be the consumption of energy to crush the same material of average size 75 mm to an average size of 25 mm: (i) Assuming *Rittenger's Law* applies? (ii) Assuming *Kick's Law* applies? Compare the results from both the laws and state which one is more reliable and Why?	[8][CO1][PO2]
	ii.	What is the difference between *open circuit* and *closed circuit* mode of grinding? Explain closed circuit grinding in detail with the help of flow diagram?	[7][CO1][PO1]
4.a.	i.	A sand mixture was screened through a standard 10 mesh screen. The mass fraction of the oversize material in feed, overflow and underflow were found to be 0.38, 0.79 and 0.22 respectively. Calculate the mass ratios of the overflow and underflow to feed and the overall effectiveness of the screen?	[10][CO2][PO2]
	ii.	Describe *Eliminators* and *Concentrators* in context with equipment for magnetic separation. Also give an account of wet drum separator, describing its principle of operation with the help of neat schematic diagram?	[5][CO2][PO1]
		(or)	
b.	i.	Describe the detailed working principles of *Grizzlies*, *Gyrating* and *Vibrating screens*. Also compare the three on the basis of particle size they handle,	[7][CO2][PO1]

efficiency and their capacity?

ii. Derive the screen effectiveness based on overflow, underflow and overall effectiveness, if the mass flow rate of feed, overflow and underflow is F, D & B respectively. Also the mass fractions of material 'A', in these three streams are X_f, X_d and X_b respectively. [8][CO2][PO1]

5a. i. The terminal settling velocity of a 6mm diameter glass sphere (ρ_P = 2500 Kg/m^3) in a viscous Newtonian liquid (ρ = 1500 Kg/m^3) is 1 mm/s. If the particle Reynold's number is small and the value of acceleration due to gravity is 10 m/s^2, then calculate the viscosity of liquid in Pa.s? Also find out drag coefficient for the glass sphere in the above condition. [8][CO3][PO2]

ii. Define *Free and hindered settling*?

If a suspension of uniform particle in water at a concentration of 500 Kg of solid per m^3. Slurry is settling in a tank and density of particle is 2500 Kg/m^3 and terminal velocity of single particle is 20 m/s. What is the settling velocity of suspension if Richardson Zaki hinder settling index is 4.6? [7][CO3][PO2]

(or)

b i. A bed of spherical glass beads (ρ_P =3000 Kg/m^3, diameter = 1mm and bed porosity = 0.5) is to be fluidized by a liquid of density 1000 Kg/m^3 and viscosity 0.1 Pa.s. Assume that the Reynold's number based on particle diameter is small as compared to one. Then calculate the minimum velocity (m/s) required to fluidize the bed. Also find out the pressure drop per unit length (Pa/m) under incipient fluidization condition. (Take, g = 10 m/s^2) [10][CO3][PO2]

ii. Explain *Thickeners* by giving a detailed account of batch and continuous thickeners, their working principle, design and thickening zone? [5][CO3][PO1]

6a. i. The basic filtration equation is given as: $\frac{dt}{dv} = \frac{\mu}{A\Delta P}\left(\frac{\alpha\, CV}{A} + Rm\right)$ [10][CO4][PO2]

Where, V is the volume of filtrate, A is the filtration area,α is specific cake resistance, μ is viscosity of filtrate and C is the conc. of solid in the feed slurry. In a 20 min constant rate filtration, 5 m^3 of filtrate was obtained. If this is followed by constant pressure filtration, how much more time in minutes will it take for another 5 m^3 filtrate to be produced? Neglect filter medium resistance (Rm) and assume incompressible cake.

ii. Write in detail about the flow patterns in agitated vessels. Also describe how swirling can be prevented in agitated vessels? [5][CO4][PO1]

(or)

b i. A cylindrical baffled vessel having height equals to diameter is scaled up for commercial purpose. N_1 and D_1 are agitator speed and diameter before scale-up; N_2 & D_2 are these parameters post scale-up. If in order to maintain an equal rate of mass transfer under turbulent conditions for a Newtonian fluid (i.e. power input per unit volume should be constant), show that ratio of agitator speed is: [10][CO4][PO2]

$$\frac{N_1}{N_2} = \left(\frac{D_2}{D_1}\right)^{\frac{2}{3}}$$

ii. With the help of neat schematic diagram, discuss the mechanism of filtration in *cake, clarifying and cross flow filters*. [5][CO4][PO1]

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