



NATIONAL INSTITUTE OF TECHNOLOGY HAMIRPUR
(An Institute of National Importance under Ministry of HRD)
Department of Chemical Engineering

CH 214 MECHANICAL OPERATION
END-SEMESTER EXAMINATION

Maximum Marks: 50 | Time: 10:00-12:00 | Date: December 16, 2020

Instructions:

- Make suitable assumptions if necessary, by clearly stating them.
- Marks will be deducted for omitting steps.
- Draw the figure wherever needed.
- **Only one file needs to be uploaded with answers written in sequence.**
- **Uploaded answer booklet must have Name, Roll No., Subject Name and Subject Code on top of first sheet and Signature with Date at the bottom of each sheet. Answer booklet without above-mentioned requirements will not be considered for evaluation.**

Q1. (10 Marks)

In a crushing roller, each roll 1 m in diameter is set so that crushing surfaces are 12.5 mm apart and the angle of nip is 32° .

- a) Can a 50 mm size of particle be fed to the crushing roller for crushing?
- b) If the actual capacity is 14 % of theoretical, calculate the throughput in kg/s when running at 2 Hz. The working face of the rolls is 0.4 m long and feed weighs 2500 kg/m^3 .

Q2. (15 Marks)

A plate and frame filter press containing 20 frames (each having dimensions 1 m by 1.2 m by 0.0254 m) is used to filter calcium carbonate slurry. The porosity of the filter cake is 32 %. The calcium carbonate particles are spherical with a diameter of $3.8 \mu\text{m}$. The density of the solid is 2.26 g/cm^3 . The viscosity and density of the filtrate are 1.65 cp and 1.06 g/cm^3 , respectively at operating temperature. The concentration of solids in the slurry is 4.8 % (mass). Assuming filtration pressure as 38 psig,

- a) Determine the volume of the slurry required to fill the press with cake.
- b) The cake is washed with water at 120°F and a pressure of 51 psig. The volume of wash water is two times the volume of liquid in the cake at the end of the filter cycle. How long does it take to wash the cake?

Q3. (10 Marks)

A solid catalyst (density 1.30 g/cm^3) is used to crack gas oil in petroleum industry. The cracking process yields high-octane blending stocks with a very fine clay as catalyst. The catalyst has approximately same specific surface ratio as quartz. The yields obtained are a function of the surface area of the catalyst. A sample of this material was first screened through the 200-mesh screen and was further sized by air elutriation. From the data given in Table Q3(A) and (B), determine

- the specific surface (cm^2/g).
- the mean surface diameter of the catalyst.

Table Q3(A)

Screened Fraction	
Mesh No. (Tyler)	Mass fraction
- 48 + 65	0.088
- 65 + 100	0.178
- 100 + 150	0.293
- 150 + 200	0.194
- 200	0.247

Table Q3(B)

Elutriated Fraction	
Size limits (μm)	Mass fraction (of original sample)
80-60	0.113
60-40	0.078
40-20	0.042
20-0	0.014

Q4. (15 Marks)

In cement industry, a wet slurry is burnt to make cement. The slurry is initially thickened to 60 % solids in a conventional thickener at the rate of 50000 kg/h of dry solids. A batch sedimentation test results the following (Table Q4):

Table Q4

Time (h)	Graduate Reading (ml volume)
0	1017
0.25	925
0.5	815
0.75	700
1	600
1.25	528
1.75	420

3.0	352
4.75	330
6.75	310
12	280
20	251
28	237
Infinity	220

Graduate height is 35 cm for 1000 ml and dry solids (sp. gr. 2.09) in test is taken as 236 g. Estimate the dimensions of the tank to handle the conditions mentioned, assuming a feed concentration similar to that used in the batch test.

*******END OF QUESTION PAPER*******