Student ID_____

Name_____

PRINCE OF SONGKLA UNIVERSITY
FACULTY OF ENGINEERING

Midterm Examination Paper: Semester 1 — Academic year : 2006
Date : July 31, 2006 — Time : 13.30 - 16.30
Subject : 230-322 Particle Engineering — Room : Robot Rm.

- Do all 5 questions. Show all your work clearly to receive credit.
- Only notes, in-class worksheets (or in-class book) and dictionary are allowed.
- If necessary to use on the back of each page, please identify the problem number.

Juraivan RATANAPISIT

No.	Pts.	Received Pts.
1	25	
2	10	
3	20	
4	25	
5	10	
Total	90	

ทุจริตในการสอบ โทษขั้นต่ำคือ ปรับตกในรายวิชาที่ทุจริต และพักการเรียน 1 ภาคการศึกษา

Student ID_____

1. (25 pts)Trap rock is crushed in a crusher as shown in Fig 1.

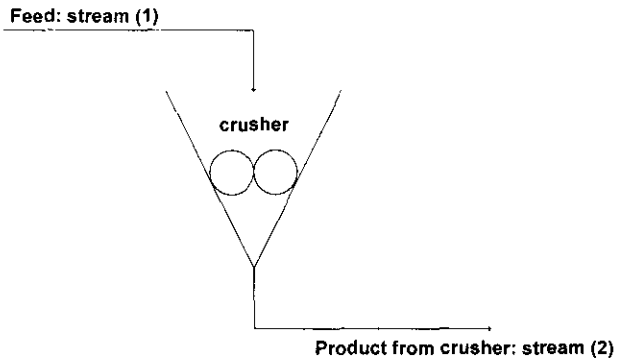

Fig 1 Trap rock size reduction process

The feed stream (1) and product stream (2) are sampled to make the screen analysis shown in Table below here.

mesh	Mass fraction of feed solid retained (feed, stream 1)	Mass fraction of solid retained (product from crusher, stream 2)
3	0.00	
4	0.20	
6	0.75	0.05
10	0.05	0.05
14		0.10
28		0.35
35		0.25
48		0.20

Given data:

1. Feed rate is 5 ton/hr
2. solid density = 1950 kg/m^3 (constant)
3. shape factor λ = 2.315

Questions: Show all your work as follows;

1.1 For feed stream 1, calculate surface area(A_w), mass mean diameter ($\bar{D}_w$)

1.2 If the mechanical efficiency of this crusher is 40%. Estimate power requirement of this process.

1.3 Based on the mass mean diameter obtained from 1.1, what type of crusher may be used? Why?

Student ID_____

2. (10 pts) The stream (2) from the crusher is separated into two fractions using an **14-mesh screen** (Tyler standard) as shown in Fig 2.

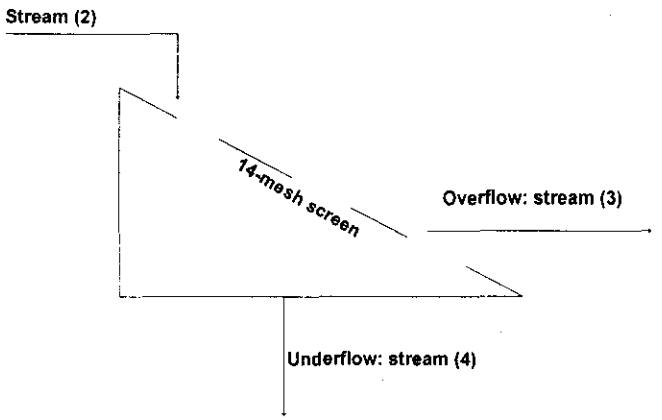

Fig 2 Separation of trap rock mixture through a standard 14-mesh screen

The screen analysis is also applied to overflow stream(3) and underflow stream(4) as shown in Table below here.

mesh	Mass fraction of solid retained. Product from crusher stream (2)	Mass fraction of solid retained from overflow stream stream (3)	Mass fraction solid retained from underflow stream stream (4)
6	0.05	0.28	
10	0.05	0.28	
14	0.10	0.39	0.10
28	0.35	0.05	0.30
35	0.25		0.25
48	0.20		0.35

Questions:

2.1 What is the overall effectiveness of the screen 14-mesh?

2.2 If the desired production rate of the underflow stream must be greater than 3 ton/hr, is the feed (stream 2) rate of 5 ton/hr possible to use in this process?

Student ID_____

3. (20 pts) A mixture of bauxite and trap rock solid particles having a size range of 0.005-0.01 m is to be separated by synthetic liquid at 300 K.

Questions:

3.1 If water in the column is at rest, calculate the size range of an uncontaminated fraction of trap rock.

3.2 If a rising stream of water is used (instead of at rest), what velocity (or velocity range) of water flow is needed to obtain an uncontaminated product of trap rock?

Given: Specific gravity of trap rock = 2.87
Specific gravity of bauxite = 2.20
Specific gravity of synthetic liquid = 0.85
Viscosity of synthetic liquid = $6.5X10^{-4}$ Pa.s

Student ID_____

4. (25 pts) A feed mixture of cream and skim milk (contains 60% by weight skim milk) is sent into a cream-separator tubular centrifuge. The centrifuge has an outlet discharge radius of light liquid 4.815 cm and outlet radius of heavy liquid 5.851 cm. The centrifuge operating is as follows:

Diameter of bowl: 20 cm	Density of skim milk: 1040 kg/m^3
Depth of bowl: 30 cm	Density of cream: 880 kg/m^3
Rotational speed: 2500 rpm	Viscosity of the skim milk: $1.5X10^{-3}$ Pa.s

Questions:

4.1 Calculate the radius of the interface neutral zone.

4.2 Calculate the expected flow rate of feed mixture in m^3/s if the mean diameter of cream droplet particle in the heavy phase is $2X10^{-6}$ m.

4.3 Calculate the centrifugal force of the mean droplet of cream particle developed at the wall bowl.

Student ID_____

5. (10 pts) A cyclone separator is used to remove sand grains form an airstream at 150°C. From Rosin Equation which we discussed in class as

$$D_{p,min} = \sqrt{\frac{9\mu B_c}{\pi N_c V_c (\rho_p - \rho)}}$$

where B_c is a constant depended only on its cross sectional area of airstream inlet channel and N_c is constant at 5.

An engineer wants to improve its efficiency by considering one of these two following methods:

1. Decrease airstream velocity to 90% of its original velocity.
2. Decrease cross sectional area to 90% of its original area.

Questions:

5.1 Are these two methods really increased its efficiency?

5.2 In your opinion, which method do you prefer? (Select only one method and explain clearly!)