SIEVING

Problem 1

Estimate the specific surface and sauter diameter of a sample of galena (specific gravity = 7.43) having the screen analysis below :

Mesh	Mass fraction
− 570 + 480	0.01
− 480 + 340	0.04
− 340 + 240	0.081
− 240 + 160	0.115
− 160 + 120	0.160
− 120 + 85	0.148
− 85 + 60	0.132
− 60 + 40	0.081
− 40 + 30	0.062
− 30 + 20	0.041
− 20 + 15	0.036
− 15 + 10	0.022
− 10 + 8	0.019
− 8	0.053

Assume Gaudin-Schumann distribution is valid for sizes below 8 mesh.

Ans: Sauuter diameter: 0.14248 mm

Problem 2:

Anthracite coal from a pulverization unit has been found to contain an excess of fine material (75% by weight). In order to remove these fines, it is screened using a 1.5 mm screen. Estimate the effectiveness of the screen from the following data :

	Mass fraction	
Particle size, mm	*Oversize from Screen*	*Undersize from Screen*
3.33	*0.143*	*0.00*
2.36	*0.211*	*0.098*
1.65	*0.230*	*0.234*
1.17	*0.186*	*0.277*
0.83	*0.196*	*0.149*
0.59	*0.034*	*0.101*
0.42	*0.00*	*0.141*

Effectiveness: 44.755%

Problem 3:

Table salt is being fed to a vibrating screen at the rate of 150 kg/hr. The desired product is – 30 + 20 mesh fraction. A 30 mesh and a 20 mesh screen are therefore used (double deck), the feed being introduced on the 30 mesh screen. During the operation, it was observed that the average proportion of oversize (from 30 mesh screen) : oversize (from 20 mesh screen) : undersize (from 20 mesh screen) is 2 : 1.5 : 1. Calculate the effectiveness of the screener from the following data :

Mesh	Mass fraction			
	Feed	Oversize from 30 Mesh Screen	Oversize from 20 Mesh Screen	Undersize from 20 Mesh Screen
– 85 + 60	0.097	0.197	0.026	0.0005
– 60 + 40	0.186	0.389	0.039	0.0009
– 40 + 30	0.258	0.337	0.322	0.0036
– 30 + 20	0.281	0.066	0.526	0.3490
– 20 + 15	0.091	0.005	0.061	0.2990
– 15 + 10	0.087	0.006	0.026	0.3470

Effectiveness: 48.6%

Problem 4:

A quartz mixture having the screen analysis shown in Table is screened through a standard 10-mesh screen. The cumulative screen analysis of overflow and underflow are given in Table . Calculate the mass ratios of the overflow and underflow to feed and the overall effectiveness of the screen.

		Cumulative fraction smaller than D_p		
Mesh	D_p, mm	Feed	Overflow	Underflow
4	4.699	0	0	
6	3.327	0.025	0.071	
8	2.362	0.15	0.43	0
10	1.651	0.47	0.85	0.195
14	1.168	0.73	0.97	0.58
20	0.833	0.885	0.99	0.83
28	0.589	0.94	1.00	0.91
35	0.417	0.96		0.94
65	0.208	0.98		0.975
Pan		1.00		1.00

McCabe, Smith 5th edition
Example 30.1

Effectiveness: 66.9%

Comminution/ Size Reduction

Problem 1

Sugar is ground from crystals of which it is acceptable that 80% pass a 500 µm sieve (Standard Sieve No.35), down to a size in which it is acceptable that 80% passes a 88 µm (Standard Sieve No. 170) sieve, and a motor working at 5 HP (working at 90% of its full power) is used for the required throughput. If the requirements are changed such that the grinding is only down to 80% through a 125 µm (No.120) sieve but the throughput is to be increased by 50% would the existing motor have sufficient power to operate the grinder? Assume Bond's law to be valid.

Ans: Yes the existing motor have sufficient power to operate the grinder (5.43 HP would be the energy requirement)

Problem 2

. A grinder is to be used (which is 8% efficient) to handle 10 tonnes per hour of a siliceous ore (specific gravity = 2.65). The feed and product analysis are given below :

The grinder costs Rs. 40,000. It operates on a 24 hour basis for 300 days per year and the maintenance, overhead and replacement costs amount to 50% of the power cost. Electricity costs 70p. per kWh. If the machine depreciates on a straight line basis for 10 years, estimate the annual processing cost of the ore if the work index of the ore is 13.57 kWh/tonne.

Screen Size, mm	Feed Mass Fraction	Product Mass Fraction
– 3.327 + 2.362	0.143	0.0
– 2.362 + 1.651	0.211	0.0
– 1.651 + 1.168	0.230	0.0
– 1.168 + 0.833	0.186	0.098
– 0.833 + 0.589	0.120	0.234
– 0.589 + 0.417	0.076	0.277
– 0.417 + 0.295	0.03	0.149
– 0.295 + 0.208	0.0	0.101
– 0.208 + 0.147	0.0	0.068
– 0.147 + 0.104	0.0	0.044
– 0.104	0.0	0.029

Ans: Annual processing cost 20.656 lakh.

Problem 3

A material is crushed in a Blake jaw crusher such that the average size of particle is reduced from 50 mm to 10 mm with the consumption of energy of 13.0 kW/(kg/s). What would be the consumption of energy needed to crush the same material of average size 75 mm to an average size of 25 mm :

a) assuming Rittinger's law applies?

b) assuming Kick's law applies?

c) assuming Bonds's law applies?

Which of these results would be regarded as being more reliable and why ?

Ans: a) 4.33 kJ/kg; b) 8.88 kJ/kg; c) 6.28 kJ/kg

Which result is reliable discussed in the class.

Problem 4

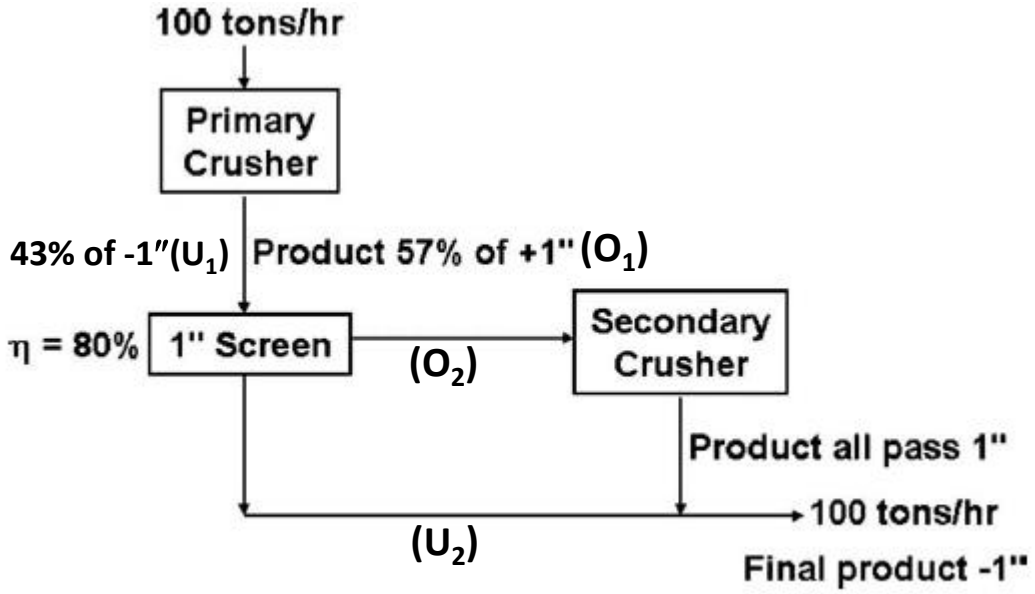
A smooth surfaced roll crusher had a roll diameter of 910 mm. Its suitability to crush an ore at 10.0 t/h was being examined. Preliminary examination showed that the kinetic friction factor was 0.36 when the speed of revolution was 33 rpm. The average diameter of particles fed to the crusher was 200 mm and the S.G. of the ore was 2.8.

Estimate:

1. the distance between the rolls,
2. the angle of nip,
3. the width of the rolls.

Problem 5

Crushed product of a primary crusher having 57% of +1″ is sent to 1″ screen. The overflow of the screen is again crushed in a secondary crusher to –1″ size and sent along with underflow of the screen as final product. Draw the crushing circuit with all details. Calculate the rate of the material crushed in secondary crusher if the effectiveness of the screen is 80% based on oversize material and the feed rate to a primary crusher is 100 tons/hr.

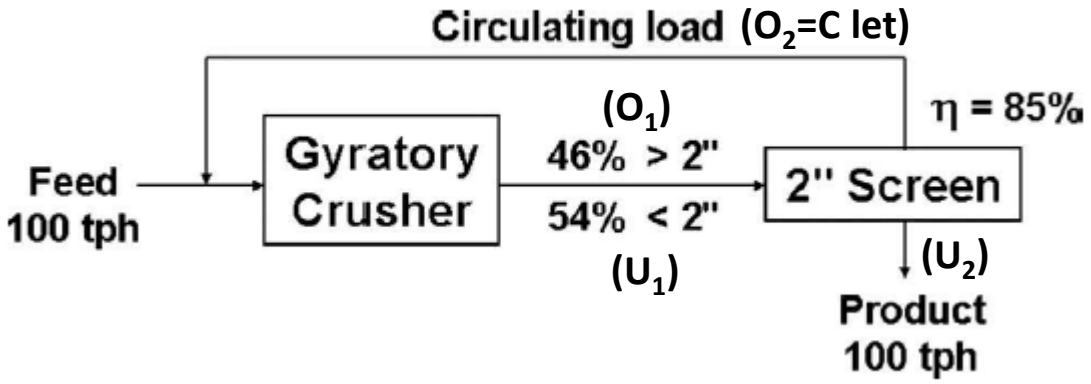


Ans : 71.25 tons/hr

Problem 6

The details of crushing plant employing gyratory crusher are as follows:
2″ square screen is in closed circuit with crusher
New feed to crusher=100 T.P.H
Crusher product contains 54% <2 and 46% > 2 fed to screen
Screen efficiency=85% (based on oversize)

Draw the flow diagram and find circulating load.
ii) Also find circulating load if the screen efficiency is based on undersize.



Ans : i) 117.95 tons/hr
ii) 117.86 tons/hr

Problem 7

In a ball mill of 2000mm diameter, 100mm diameter steel balls are being used for grinding at a speed of 15 rpm. At what speed will the mill have to run if the 100mm balls are replaced with 50mm balls, all the other conditions remaining same?

Ans: Operating speed of the mill = 14.79 rpm