Performance studies on the crushing and screening circuit at South Bank Treatment Plant of Hindustan Copper Ltd.

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INTRODUCTION :

The global energy crisis, inflation and financial difficulties, spiralling increase in operating costs against non-remunerative prices of the finished products are generally the constraints for expansion and modernisation of any mineral processing plant today. However, a very careful look is warranted for before taking any investment decision and a prudent justification for evaluation of the full potential of any plant. The Treatment Plant at South Bank (TPSB) is a typical old plant of HCL/ICC and is the subject of present study.

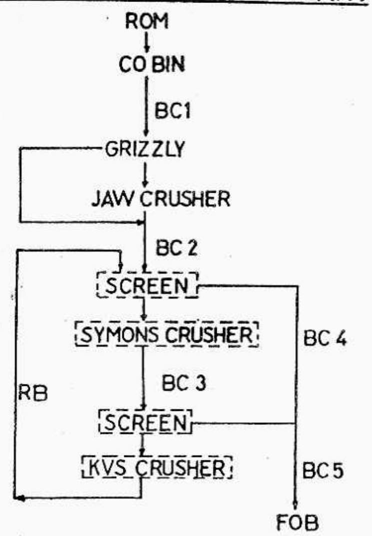
The paper deals with the work carried out in the crushing and screening section of the plant in which the limitations of the existing circuit have also been indicated.

Plant details :

TPSB treats the ore from Surda, South Surda and Kendadih mines and has a capacity of 1000 tpd.

The ROM ore, 300 mm in size is received at the feed hoppers through dumpers. The ore is fed to the primary jaw crusher (size 40x100cm) set at 75 mm by conveyor belt via a scalping grizzly with 75 mm opening. The primary crushed product along with the grizzly undersize is fed to a single deck screen (size 300x120 cm) having 25 mm aperture. The screen oversize is fed to a 120 cm standard Symons cone crusher set at 25 mm. The undersize of the screen is carried to the fine ore belt. The product of the Symons cone crusher is conveyed to another single deck screen having 25 mm aperture. While the screen undersize is fed to fine ore belt, the oversize is further crushed in a KVS reduction gyratory crusher (size 93cm) set at 12 mm. The product of the KVS crusher is circulated back to the screen placed ahead of the Symons crusher. The fine ore is transported to the fine ore bin. The flow sheet of the crushing plant is given in Fig. 1.

FLOWSHEET OF CRUSHING PLANT



BC-BELT CONVEYOR
RB-RETURN BELT
COB-COARSE ORE BIN
FOB-FINE ORE BIN

FIG.1

The crushed ore is ground in five ball mills in close circuit with rake classifiers to produce a

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flotation feed having 50 percent passing 200 mesh. Flotation is carried out in pneumatic cells consisting of roughing and scavenging banks.

The rougher concentrate is taken off as the final product and is thickened, filtered and despatched to the smelter. The tailings are deslimed for recovery of sand and the slimes are disposed of.

Operating problems and objectives of study :

The throughput of the crushing plant has all along been a constraint and the crushing rate has not exceeded 60 tph, at 25 mm screen aperture and at lower apertures it has even been less. This, coupled with the limited storage capacity available in the plant for both coarse and fine ores, has made the crushing plant a bottleneck for even routine operations, leave alone any enhancement in capacity. The lower crushing capacity has required the plant to operate in all three shifts and this has resulted in lower plant availability due to non-availability of time for maintenance. Also the power consumption per tonne of ore crushed has been recorded to be higher by 0.5 to 1 unit than that for other similar plants in the ICC complex.

In order to clearly understand the reasons for the lower crushing rate as also to help the management in deciding whether minor modifications will be sufficient or extra facilities will be required to be installed for augmenting the capacity of the crushing plant, a detailed study of the circuit was undertaken.

Sampling strategy and data collection :

Because of the typical problems of sampling in a crushing plant, the following strategies were adopted.

a) The feed and products of the secondary and tertiary crushers and screens were considered for this purpose. The entire plant was stopped when the system was running at a steady state and samples were collected from the belts feeding the screens as well as from the belts carrying the products of the crushers and screens.

b) Samples were collected over 3 meter length for all belts.

c) The samples collected were sieve analysed from 3.75 cm size to 0.6 cm size.

d) The data obtained were used for calculating:

i) the screen efficiency at various size fractions (the 1.25 cm being the most important).

ii) the behaviour of screens at various feed rates.

iii) the behaviour of the secondary and tertiary crushers at various settings.

Sampling campaign was started on the above lines and after collection of the first few sets it was observed that :

a) Collection of screen oversize by specially designed boxes was not giving proper samples as lot of fines were escaping.

b) Sampling length for all belts except that for belt No. 2 which carries jaw crusher product (which contains more than 7.5 cm size particles) could be reduced to 1 meter without affecting sampling accuracy.

Based on the above, the sampling strategy was modified and samples were collected from all the conveyor belts starting from belt No.2. Altogether about 20 sets of samples were collected at various feed rates and crusher settings. One typical set of data is given in Table 1.

Analysis of data :

As stated earlier the purpose of data collection was :

a) to define the screen behaviour

b) to determine the characteristics of the secondary and tertiary crusher products.

Before proceeding with the calculations mentioned above, the material balance around the circuit was calculated to check the accuracy of sampling. A typical calculation is shown in Figure 2.

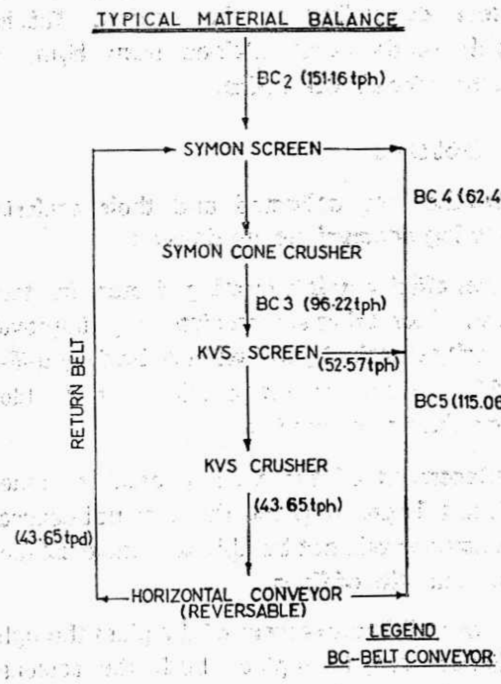

FIG. 2

The important points to be noted in the calculations are :

a) The materials flow rates on each belt have been calculated by multiplying the weight per unit length by the speed of the belt.

b) The materials flow on belt No. 2 need not necessarily tally with that on belt No.5 because the true steady state is very difficult to achieve in any operating plant, particularly, the crushing circuits.

c) The material flow from the underflow of KVS screen has been calculated by substracting the material on belt No. 4 from that on belt No. 5.

d) The accuracy of sampling has been checked by comparing the measured quantity of material on belt No. 3 with that calculated by adding the materials on return belt and underflow of KVS screen. This figure has been written in the bracket. It may be observed that the differences between the two figures is marginal and are within the acceptable limits in this type of work.

Having thus satisfied that the material balance around the circuit is true, the sieve analysis data of the various points in the circuit was used to calculate the screen efficiencies for both the screens. A typical calculation for determining screen efficiency of secondary screen is given in Table-2. From Table 2 it can be seen that

a) the efficiency of separation at 12.5 mm is around 50 percent.

b) the screen undersize does not contain any 25.0 mm material.

In the present plant practice, it has been found over the years that crushing to 12.5 mm size is the most optimum and hence it was decided to carry out efficiency calculation only upto 12.5 mm. The reasons for such a step were ;

a) It is more important to know the content of +12.5 mm in the crushing plant product than —12.5 mm size.

b) Since the plant capacity is already a bottleneck with 25 mm opening aperture in the screens, there is no possibility of reducing opening sizes to less than 12.5 mm size.

Efficiency figures from 37.5 to 12.5 mm were thus determined for various tests for both the screens and these are given in Table 3. The data clearly shows that the efficiency is quite low. To have a better understanding of nature of the screen efficiency and to determine at which feed rate the efficiency can be improved further the screen efficiency at —12.5mm size was plotted against the quantity of —12.5mm size particles in screen feed for both the screens. This is given in Fig 3. It is evident from the figure that the screen efficiency is almost at the peak under existing situations.

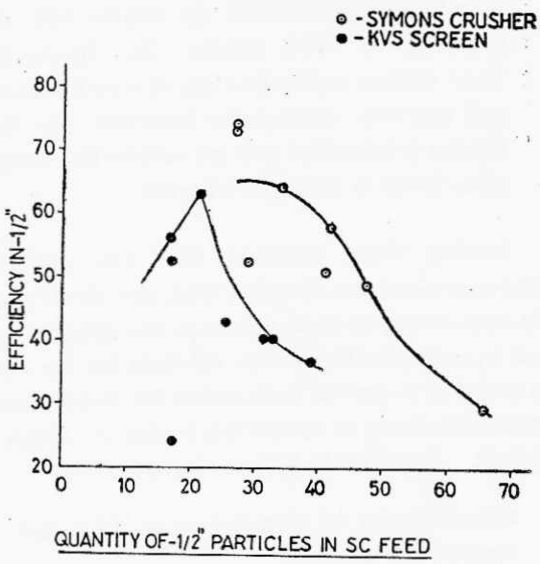

Fig. 3

As regards the other objective of characterising the products of the secondary and tertiary crushers, the following were obtained from the data collected :

a) The product size for secondary crusher is quite consistent and is keeping with the catalogued values for Symons crusher.

b) The percentage – 12.5mm size particles in the KVS crusher product varies between 15-40 percent depending on the setting. This is much less than that obtained from Symons crushers for similar duties.

CONCLUSIONS :

From the data collected and their analysis the following conclusions are drawn :

i) Screen efficiency is a limiting factor in the plant. Increasing screen size may improve capacity marginally but will not be fully utilised because the tertiary crusher is not able to produce requisite fines.

ii) Replacement of the tertiary crusher alone will not improve plant throughput because the screens will not be able to handle all the extra quantity of fines.

iii) For overall improvement of the plant throughput, it is necessary to replace both the screens and the tertiary crusher.

Table –1 : Typical sieve analysis data around the crushing circuit

Screen size	Sieve analysis (percent retained)				
	BC—2	BC—3	BC—4	BC – 5	Return
$1\frac{1}{2}$" (37.5 mm)	62.67	6.59	—	—	—
$1\frac{1}{4}$" (31.0 mm)	5.99	14.29	—	—	1.26
1" (25.0 mm)	3.57	17.03	—	—	15.09
$\frac{1}{2}$" (12.5 mm)	10.24	38.46	32.19	37 77	52.83
$\frac{3}{8}$" (9.5 mm)	4.40	2.20	13.01	13.67	8.81
$\frac{1}{4}$" (6 mm)	6.15	7.14	17.12	16.56	8.81
—$\frac{1}{4}$" (—6 mm)	6.98	14.28	37.67	32.01	13.21

Note : BC — Belt conveyor.

Table–2 : Calculations of screen efficiency

Size	New feed (158.16 TPH)	Returns (43.65 TPH)	Total (TPH)	Screen under size (TPH)	Screen over size (TPH)	Screen* efficiency %
1½" (37.5 mm)	99.12	–	99.12	—	99.12	100
1¼" (31.0 mm)	9.47	0.55	10.02	—	10.02	100
1" (25.0 mm)	5.65	6.59	12.24	—	12.24	100
½" (12.5 mm)	16.20	23.06	39.26	20.12	19.14	48.75
⅜" (9.5 mm)	6.96	3.85	10.81	8.13	2.68	24.79
¼" (6.0 mm)	9.73	3.85	13.58	10.70	2.88	21.21
–¼" (—6.0 mm)	11.04	5.77	16.81	23.54	—	—

* With respect to over size of screen.

Table—3 : Screen efficiency data

Test No.	Symon screen*				K. V. S. Screen*			
	1½" (37.5 mm)	1¼" (31.0 mm)	1" (25.0mm)	½" (12.5 mm)	1½" (37.5 mm)	1¼" (31.0 mm)	1" (25.0 mm)	½" (12.5 mm)
6	100	100	100	48.04	100	100	100	43.61
10	100	100	100	70.04	100	100	100	62.83
11	100	100	100	41.76	100	100	100	59.11
12	100	100	100	50.84	100	100	100	56.52
14	100	100	100	48.75	100	100	100	36.94

* With respect to over size of screen.

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