Proceedings of the International Seminar on Mineral Processing Technology - 2006, Chennai, India. pp. 537 - 543.

Influence of the Static Screen Inclination on the Effective Separating Size and Concentration of Beach Sand Minerals

Ranjita Swain, A.K. Sahoo and **R. Bhima Rao**

Regional Research Laboratory, (CSIR), Bhubaneswar, 751 013

Abstract

In this paper an attempt has been made to evaluate the effect of inclination of micro screen on the effective separating size of beach sand minerals. The results of these investigations indicate that the cut sizes of 130μm, 122μm, 63μm, 55μm and 40μm could be obtained from a feed containing –1mm size range with a variable deck inclination such as 35°, 40°, 67°, 70° and 75° respectively. The cut sizes are evaluated based on the partition curve according to Tromp. The typical size analysis data obtained at cut size of 63μm, indicate that the overflow and +300μm size fraction of the under flow contain rejectable tailings amounting to 51% by weight with overall heavies loss contain 4.7%, Thus micro screen is effective for dual purpose such as classifications like hydrocyclone and preconcentration like a spiral concentrator. Hence, it can be concluded that the micro screen is not only an effective for classification at different cut points but also can work as a good preconcentrator for beach sands.

Keywords: *Micro screen, beach sand, hydro cyclone, spiral concentrator, under flow, over flow, Tromp curve.*

INTRODUCTION

Hydro cyclones are mainly used for classification of granular materials with cut size below 1mm because screening materials have a very low capacity especially in the very fine size range and are not working satisfactory. Numerous hydrocyclone classifiers have already been developed, but most of them produce fractions of equal settling rates. Moreover, hydrocyclone classifiers are not effective for separating at different cut sizes, such as 1mm, 0.1mm, 0.04mm etc. from a feed containing very wide size range between 6mm to 0.04mm. Such hydrocyclone classifiers are not useful for preconcentration of beach sand minerals. Spiral concentrators are widely used for preconcentration of these sand minerals but not for a specific cut size. The duel role function machine will be more advantage than using two different types of units. Efforts are made for a long time past to develop screening machine called "Micro Screen" which will be suitable for separation of granular materials at different cut sizes from a wide feed size range. Micro screens are static and relatively steep with adjustable angles varies from 35° to 75° and straight screen, with slits at right angles to the direction of movement and vibrated time to time in order to remove near mesh or sticky particles from the surface. An attempt is made so far on the use of micro screen in classification of iron ore slimes [Cordes and Cologne, Internet data] and separation of values from tailings [Sahoo et al, 2005]. However, since so far no one has attempted to classify the beach sand to a specific cut size and at the same time to obtain a preconcentrate, an attempt is made in this paper to find out the applications of the micro screen for classification and preconcentration.

MATERIALS AND METHODS

Beach sand sample was collected from the east coast of Andhra Pradesh. Size analysis of the sand was carried out by using Indian standard sieves. Classification studies were carried out using micro screen

at different deck angles such as 35°, 40°, 67°, 70° and 75°. Cut sizes of the feed for each deck angle was calculated by using

Equation –I

$$\text{Cos. } \theta / da \qquad \text{Equation -I}$$

Where θ = deck angle and
da = deck aperture, 0.16 mm constant

Micro screen used for this purpose, is a laboratory model, No. S3-160e, manufactured by Humboldt Wedag, Germany. All the experiments were carried out on this screen with a batch of 10 kg sample. Initially, the sample was well stirred and poured directly on the desired inclination of static micro screen and at once the under flow as well as the over flow products of the screen were collected separately. One-second vibration was given to the micro screen for collecting the near mesh size particles left in the screen. The whole process was taken one minute time duration. The cut size of the micro screen product was evaluated by partition factor percent and tromp curve. The tromp curve was drawn based on the equation –II

$$(c \times x) / (b \times y + c \times x) \times 100 \qquad \text{Equation -II}$$

where

- b = weight of particle fraction, % in the under size suspension from the screen
- c = weight of particle fraction, % in the over size, slurry over the screen
- x = product by weight in the over size slurry over the screen and
- y = product by weight in the under size slurry from the screen.

Since the slope of the partition curve is also a measure of the separation efficiency, the separation efficiency or separation inefficiency, can also be characterized by the so called E_T value. The E_T value, the specific cut size of the feed, was determined from the half difference particle sizes corresponding to T = 75 and T = 25 and the data were compared from the data obtained by equation II. A typical product obtained by micro screen at 67° deck angle was further evaluated for preconcentration studies. All the size fractions of underflow and over flow were subjected to sink float studies by using bromoform, 2.98 specific gravity. The percent of total heavy minerals were calculated based on the sink weight percent.

RESULTS AND DISCUSSIONS

The size analysis of ROM feed, micro screen under flow and over flow, weight percent and partition factors obtained at different deck angles such as 35°, 40°, 67°, 70° and 75° are shown in Tables 1 to 3.

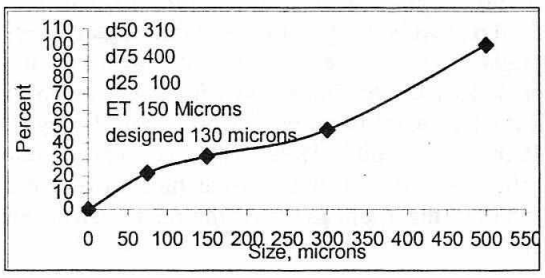

Fig. 1: Tromp Curve for Beach Sand at 35 Degree Deck of Micro Screen

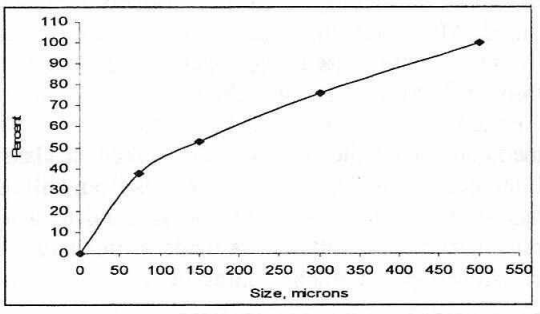

Fig. 2: Tromp Curve for Beach Sand at 35 Degree Deck Angle of Micro Screen

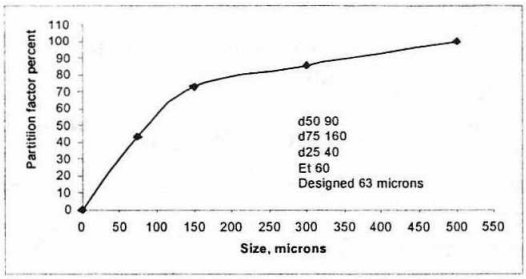

Fig. 3: Tromp Curve for Beach Sand Classification at 67 Degree Deck Angle of Micro Screen

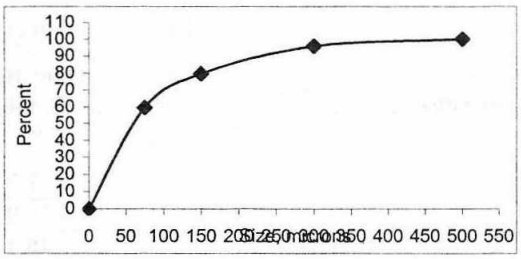

Fig. 4: Tromp Curve for Beach Sand Sample at 70 Degree Slope of Micro Screen Deck

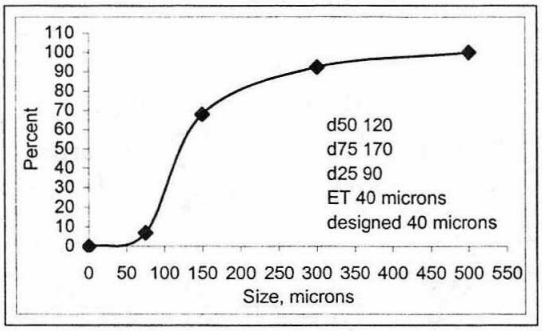

Fig. 5: Tromp Curve for Beach at 75 Degree Deck Angle of Micro Screen

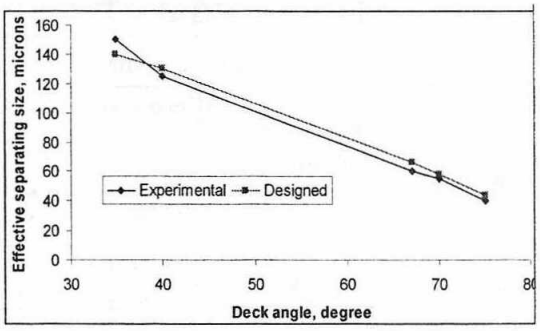

Fig. 6: Influence of the Screen Inclination of the Effective Separating Size Separation for Beach Sand

The data indicate that with increase of deck angle, the overflow weight fraction percent is decreasing. Further, the data indicate that the over flow or the coarse size fraction contain minimum amount of fines. The effect of deck angle on specific cut size of the feed obtained at 35°, 40°, 67°, 70° and 75° are also shown in Figs. 1 to 5 and the summary of this data are shown in Table. 4. The experimental data or tromp curve data, shown in Fig. 6, indicate that the specific cut size values of the beach sand obtained from different deck angles are almost near to the values designed by the micro screen except at the lowest angle 35°. The more accurate cut size may be obtained by using another aperture size deck and deck angle. The average size analysis of the micro screen under flow and over flow obtained at 67° and the feed size analysis are shown in Table 4 and Fig. 7. The data indicate that the size analysis trend is almost similar with the feed size analysis and average size analysis of the micro screen products.

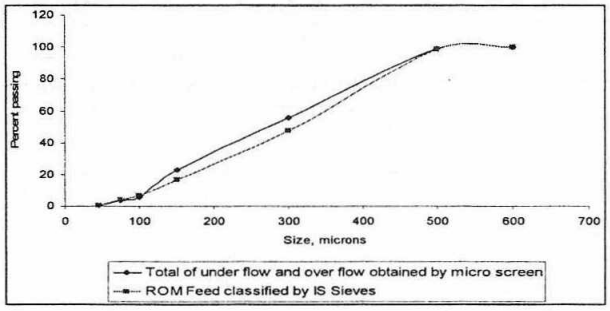

Fig. 7: The Average Size Analysis of Micro Screen under Flow and Over Flow and ROM Feed Size Analysis

Table 1: Effect of Micro Screen Deck Angle on Size Classification

Size, microns	Feed Weight, %	Micro screen deck angle, 35°			Micro screen deck angle, 40°		
		Under flow Weight, %	Over flow Weight, %	Partion factor, %	Under flow Weight, %	Over flow Weight, %	Partion factor, %
500	1.7	-	1.2	100.0	-	1.9	100
300	50.9	20.8	36.0	48.0	21.2	44.8	75.8
150	30.8	52.4	46.4	32.1	53.8	40.6	52.8
75	12.7	22.0	11.8	22.2	20.2	8.3	37.8
-75	3.9	4.8	4.6	-	4.8	4.4	-
Total	100.0	100.0	100.0	-	100.0	100.0	-
Fraction	100.0	34.8	65.2	-	59.7	40.3	-

Table 2: Effect of Micro Screen Deck Angle on Size Classification

Size, microns	Feed Weight, %	Micro screen deck angle, 67°			Micro screen deck angle, 70°		
		Under flow Weight, %	Over flow Weight, %	Partion factor, %	Under flow Weight, %	Over flow Weight, %	Partion factor, %
500	1.7	-	4.4	100.0	-	8.1	100
300	50.9	37.0	63.5	85.5	26.0	71.9	95.8
150	30.8	34.6	27.0	72.9	51.8	16.9	72.9
75	12.7	23.3	5.1	43.0	17.5	3.1	59.4
-75	3.9	5.1	-	-	4.7	-	-
Total	100.0	100.0	100.0	-	100.0	100.0	-
Fraction	100.0	77.5	22.5	-	89.2	10.8	-

Table 3: Effect of Micro Screen Deck Angle on Size Classification

Size, microns	Feed Weight, %	Micro screen deck angle, 75°		
		Under flow Weight, %	Over flow Weight, %	Partion factor, %
500	1.7	-	4.1	100.0
300	50.9	22.7	64.5	92.4
150	30.8	53.6	26.7	67.9
75	12.7	18.3	2.9	4.0
-75	3.9	5.4	1.7	-
Total	100.0	100.0	100.0	-
Fraction	100.0	80.9	19.1	-

Table 4: Summary of Data Obtained on the Effect of Micro Screen Deck Angle for Desired Cut Size

Size, microns	35°	40°	67°	70°	75°
d_{50}	310	130	90	60	120
d_{75}	400	295	160	140	170
d_{25}	100	45	40	30	90
ET	150	125	60	55	40
Cut size*	130	122	63	55	40

*Desired cut size: Cosθ X 0.16 mm (Screen aperture)

The effect of micro screen classification at deck angle 67° on selective size separation of heavies is shown in Table 6. The data indicate that the percentage of total heavy minerals obtained from the micro screen products is 29.3% and the percentage of total heavy minerals found in the ROM feed is 29.4%. The under flow of the micro screen contain 77.3% by weight with 26.3% of the total heavy minerals. The over flow of the screen contain 22.7% by weight with 3% of the total heavy minerals. It can be seen from the size analysis of the ROM feed and MS total that the weight percent is decreasing from 500-micron size fraction and this observation is more significant at 300-micron size from the products obtained from the micro screen. The ROM feed contains 50.9% by weight in -500 +300 micron size fractions and where as in micro screen products, the -500 +300 micron size fractions contain 43% only. This observation can clearly be seen from the size fractions of -500 +300 microns of under flow and over flow of the screen and Figs. 8 and 9. This may be due to near mesh size particles of heavy minerals are selectively trapped out from the quartz minerals. The conceptual flow sheet and material balance for pre concentration of beach sand by using micro screen, shown in Fig. 10, indicate that rejectable tailings containing 22.7% by weight in the over flow with over all tailing

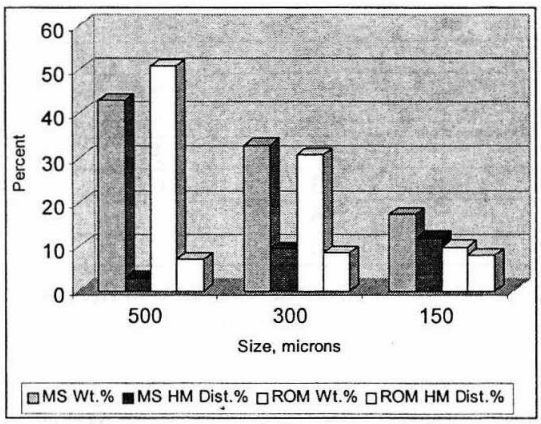

Fig. 8: Size Analysis of ROM Feed and Micro Screen Products (Under Flow + Over Flow)

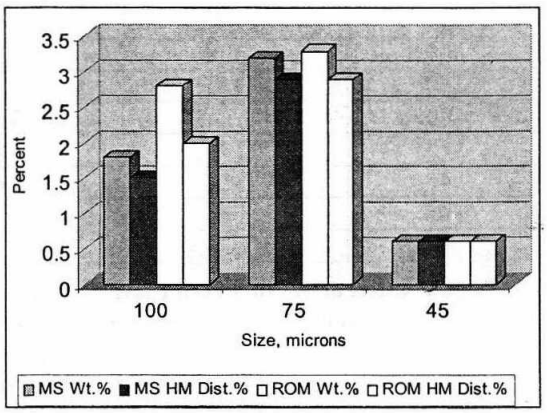

Fig. 9: Size Analysis of ROM Feed and Micro Screen Products (Under Flow + Over Flow)

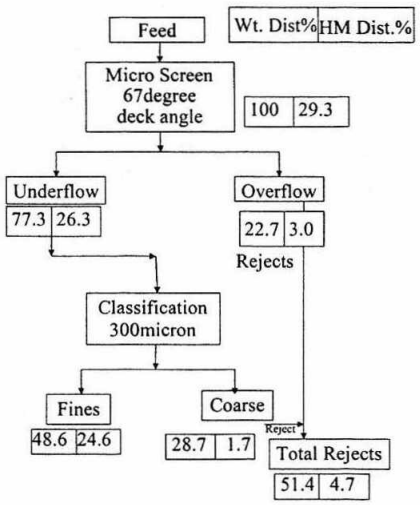

Fig. 10: Conceptual Flow Sheet and Material Balance for Preconcentration of Beach Sand by using Micro Screen

loss contain 3% total heavy minerals from a feed contain 29.3% total heavies. Further the quantity of tailings could also be increased by classification of under flow product at +300 micron size. Hence the total tailings could be 51.4% by weight with 4.7% total heavy minerals. Since, the micro screen, basically operates as static screen, is effective for dual purpose such as classifications like hydro cyclone and pre concentration like a spiral concentrator and operates with specific throughput of 5.2 tons/m^2 X hour and the power cost of the screen is very low because the unit needs vibration one minute per hour to remove near mesh size particles or sticky materials, an attempt is essential for large scale continuous studies.

Table 5: Comparison of Size Analysis of Beach Sand Data Obtained by IS Sieves and From Micro Screen Classification

Size, microns	Total of under flow and over flow obtained by micro screen		ROM Feed classified by IS Sieves	
	Weight, %	Cum. Wt. % pass	Weight, %	Cum. Wt. % pass
600	-	100.0		100.0
500	1.1	98.9	1.7	98.3
300	43.0	55.9	50.9	47.4
150	32.9	23.0	30.8	16.6
100	17.4	5.6	9.9	6.7
75	1.8	3.8	2.8	3.9
45	3.2	0.6	3.3	0.6
-45	0.6		0.6	
Total	100.0		100.0	

Table 6: Effect of Micro Screen Classification at Deck Angle on Selective Size Separation of Heavies Conditions: Experimental Cut Size According to Tromp Curve: 60 Microns Designed Cut Size at 67° Deck Angle: 63 Microns

Size, microns	MS Under flow		MS Over flow		MS Total		ROM Feed	
	Weight, %	Heavies Dist. Wt. %	Weight, %	Heavies Dist. Wt. %	Weight, %	Heavies Dist. Wt. %	Weight, %	Heavies Dist. Wt. %
500	-	-	1.1	-	1.1	-	1.7	0.05
300	28.7	1.7	14.3	1.2	43.0	2.9	50.9	7.2
150	26.8	8.3	6.1	1.2	32.9	9.5	30.8	8.6
100	16.4	11.4	1.0	0.5	17.4	11.9	9.9	8.0
75	1.6	1.4	0.2	0.1	1.8	1.5	2.8	2.0
45	3.2	2.9	-	-	3.2	2.9	3.3	2.9
-45	0.6	0.6	-	-	0.6	0.6	0.6	0.6
Total	77.3	26.3	22.7	3.0	100.0	29.3	100.0	29.4

CONCLUSIONS

The following conclusions are drawn from the experiments carried out on beach sand by using micro screen.

- The results of these investigations indicate that the cut sizes of 130μm, 122μm, 63μm, 55μm and 40μm could be obtained from a feed containing –1mm size range with a variable deck inclination such as 35°, 40°, 67°, 70° and 75° respectively.
- The cut sizes are evaluated based on the partition curve according to Tromp and it is observed that both the designed cut size and experimental cut sizes obtained for the beach sand are almost matching.

- The typical size analysis data obtained at cut size of 63μm, indicate that the overflow and +300μm size fraction of the under flow contain rejectable tailings amounting to 51% by weight with overall heavies loss contain 4.7%,
- Thus micro screen is effective for dual purpose such as classifications like hydrocyclone and preconcentration like a spiral concentrator.
- Hence, it can be concluded that the micro screen is not only an effective for classification at different cut points but also can work as a good preconcentrator for beach sands.
- An attempt is essential for large-scale continuous studies to establish these findings.

ACKNOWLEDGMENTS

The authors wish thank to Dr. R.K. Galgali, Acting Director for his kind approval to publish this paper. The authors also wish to thank to Mr. P.S.R. Reddy, Head, MP & ET for his constant encouragement to carry out this work and time to time giving suggestions on this subject matter.

REFERENCES

[1] Cordes, H.B. H. and Cologne, H.H, Classification of very fine materials at high through put rates with a new micro screen, Internal publication of Humbold Wedag, Germany.

[2] Sahoo, A.K, Swain Ranjita and Bhima Rao, R, Applications of static screens for recovery of placer values from spiral tailings, communicated to SAGAT journal, 2005.