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СЕПАРАЦИЈА НА ХРОМИТ ВО ТЕШКА СРЕДИНА: ПЕРФОРМАНСИ И КОМПЈУТЕРСКА ПРЕЗЕНТАЦИЈА

THE CHROMITE HEAVY MEDIUM SEPARATION: PERFORMANCE AND COMPUTER PRESENTATION

M. GOLOMEOVA, B. KRSTEV* & B. GOLOMEOV**

Introduction

The gravity separation, specially heavy medium separation with their trends and interest have occured as the necessity to treat more and more low grade ores increasing the energy costs. These have led to a broader application of pre-treatment methods in an effort to reduce the amount of energy-intensive operations, such as fine grinding, flotation and filtration that are needed.

Gravity separation is essentially "a method of separating particles of minerals of different specific gravities by reason of their differences in movement in response to the joint simultaneous actions upon them of gravity and one or more other forces".

It`s generally accepted that gravity separation is the simple and economical of all methods of concentration. Its use is recommended wherever practical as it permits the recovery of values at as coarse a size range as possible, reducing the costs involved in crushing or grinding and reduces slime losses which usually result from size reduction operations. Gravity separation methods fall into following categories: heavy-medium separation, in which the particles are immersed in a bath containing a medium of intermediate density, so that some particles float and other sink; separation in vertical currents, such that advantage is taken of differing rates of settlement, as typified by jigging; and separation in streaming currents, or "thin film sizing" as for example on a shaking table or spiral separator.
Laboratory testing is performed on different ores in order to asses the suitability of heavy medium separation on the crushed minerals and to determine the economic separating density. The crushed ore sample is immersed in a heavy liquid, and then particles of high specific graviry relative to the liquid sink rapidly, but particles of low specific gravity rise rapidly.
The efficiency of separation is represented by the slope of a PARTITION, or TROMP CURVE, which describes the separating efficiency for the separator and may be used for comparision and estimation of performance. The partition curve relates the PARTITION COEFFICIENT, or the percentage of the feed material of a particular specific gravity which reports to the sinks product, against specific gravity.

The PROBABLE ERROR OF SEPARATION or the ECART PROBABLE (Ep) is defined as half the difference between the density where 75% is recovered to sinks and that at which 25% is recovered to sinks.

* Faculty of Mining & Geology - Stip, Republic of Macedonia

$$E_p = \frac{A-B}{2} \qquad (1)$$

The EFFECTIVE DENSITY OF SEPARATION is shown when the density at which 50% of the material report to sink. The ideal separation has a vertical line and Ep=0, or in the practice usually is in the range 0,02-0,08.

We must remind that there are a great number of functional representations fo "S" shaped curves that have been used in representing partition curves. For example:

$$y(x) = 100 - 50 \exp [(x - x')/ z] \qquad (2)$$

where : y(x)- is recovery of component to the floats fraction (%);
x - is the specific gravity of the component;
x' - is the specific gravity of separating density;
z - is constant.

There are two possibilities: (x> x' or x=x') and

$$y(x) = 50 \exp [(x' - x)/ z] \qquad (3)$$

$$y(x) = 50 \qquad (4)$$

When y(x) = 75% and (x' - x) = Ep then,

$$z = -Ep / \ln 0,5 \qquad (5)$$

The mathematical expression that is used to determine various performance criteria developed by Wizzard is known as a **Weibull function** with the form as:

$$y(x) = 100\left[y_0 + a \cdot \exp\left(-(x - x_0)^{b/c}\right)\right] \qquad (6)$$

where x_0 , y_0 , a , b and c are constants whose values must be determined for each partition curve. Values of these dependent constants can be determined by means of appropriate non-linear regression techniques.

Jowett has also analysed the mathematical form of curves using the binomial expansion to simulate the probable distribution of components of different densities arising from stratification in gravity devices. The curves have normal distribution form.

In this paper will be shown the possibility of the computer program performance of the gravity concentration from low grade domestic (macedonian) chromite ore.

The Performance of Chromite Ore Separation

The experimental investigations of the chromite ore gravity separation are performed on the macedonian domestic ore "Vitina Padina" of the following chemical composition:

Table 1. – Chemical composition of the "Vitina Padina" – ore

Cr_2O_3	26.23 %
FeO	11.36 %
SiO_2	19.20 %
Al_2O_3	5.20 %
CaO	1.77 %
MgO	26.96 %
L.H.	9.22 %
Total	99.94 %

The particle - size analysis of the crushed ore with the chromite Cr_2O_3 distribution in the size range is ahown on the Table 2. The performance of the chromite ore heavy medium separation is evaluated in the solution (mixture C_2Br_4+CCl_4) in the following ranges: 2,4; 2,5; 2,6; 2,7; 2,8 & 2,9 gr/cm^3. In order to interpret gravity separation of chromite ore and for predicting the performance of heavy medium circuit, was developed computer program about evalution of heavy liquid data.

Table 2. – Particle - size analysis of the chromite Cr_2O_3

Size range [mm]	Fractions M (%)	ΣM (%)	Distribution Cr_2O_3 (%)	M (%) * Cr_2O_3 (%)	I (%)
−8.00 + 6.68	13.8	13.8	16.97	234.186	
−6.68 + 4.69	5.9	19.7	17.04	100.536	
−4.69 + 3.32	5.5	25.2	16.91	93.005	
−3.32 + 2.36	3.8	29.0	17.29	67.702	
−2.36 + 1.65	3.4	32.4	17.16	58.344	
−1.65 + 1.16	2.6	35.0	17.71	46.046	
−1.16 + 0.83	2.2	37.2	18.35	40.370	
−0.83 + 0.50	3.7	40.9	21.89	80.993	
−0.50 + 0.00	50.1	100.0	33.15	1959.165	
−8,00 + 0.00	100.0		26.78	2678.347	

−8.00 + 0.50	**40.9**	**17.58**	**719.182**	**26.85**
−0.50 + 0.00	59.1	33.15	1595.165	73.15
−8.00 + 0.00	100.0	26.78	2678.347	100.00

Table 3. – Chromite ore evaluation size range (−8.00 + 0.50 mm)

Specific gravity fraction	Feed m (%)	Cr_2O_3 (%)	Distribution $I_{Cr_2O_3}$ (%)	$\Sigma I_{Cr_2O_3}$ (%)
− 2.40	0.79	0.44	0.020	0.020
2.40 – 2.50	17.32	1.44	1.438	1.458
2.50 – 2.60	20.47	3.80	4.423	5.881
2.60 – 2.70	13.70	8.44	6.517	12.398
2.70 – 2.80	7.24	12.21	5.026	17.424
2.80 – 2.90	8.20	16.66	7.767	25.191
+ 2.90	32.28	40.76	74.809	100.000
Σ	**100.00**	**17.58**	**100.000**	

RUN

Input NEW if new data being entered
Press RETURN for demonstration data
?
Data for heavy liquid analyses at 6 densities and 4 sizes have been entered

SIZE RANGE

DENSITY	– 8 + 4.46 mm		– 4.46 + 2.36 mm		– 2.36 + 1.16 mm		– 1.16 + 0.5 mm	
[g/cm^3]	M %	Cr_2O_3 %	M %	Cr_2O_3 %	M %	Cr_2O_3 %	M %	Cr_2O_3 %
+ 2.9	33.74	39.92	29.63	38.39	29.16	41.53	36.21	44.62
- 2.9 + 2.8	5.73	15.92	9.78	16.02	10.88	17.34	8.73	18.52
- 2.8 + 2.7	13.53	9.59	8.66	10.58	6.37	11.11	4.58	12.40
- 2.7 + 2.6	16.04	5.88	15.20	6.33	13.04	7.24	8.63	6.68
- 2.6 + 2.5	16.56	4.23	20.90	3.86	22.07	3.59	18.53	4.13
- 2.5 + 2.4	13.74	0.88	14.99	1.11	17.56	1.16	22.58	1.89
- 2.4	0.66	1.40	0.84	1.33	0.92	1.11	0.74	2.00
Σ	100.00	17.12	100.00	15.80	100.00	16.65	100.00	20.13
Mass %	22.71		14.21		9.74		9.39	

Undersize fraction (-o,5 mm) is 43,95% weight and contains 34,85% Cr_2O_3.

PREDICTED ECART PROBABLE (Ep)

Input expected Ep for each size fraction
Ep for size fraction +4,46 mm
?0,13
Ep for size fraction +2,36 mm
?0,13
Ep for size fraction +1,16 mm
?0,13
Ep for size fraction +0,5o mm
?0,13

SEPARATION DENSITIES

Input density of separation for each size fraction
Separation density for size fraction +4,46 mm
?2.8
Separation density for size fraction +2,36 mm
?2.8
Separation density for size fraction +1,16 mm
?2.8
Separation density for size fraction +0,5o mm
? 2.8

FLOTATION PERFORMANCE

Input expected flotation yield (%)
If fines to be discarded press RETURN
If fines to be blended directly then input 100
?

Size range	Mass %	Cr_2O_3 %	SG	Ep	Float M %	Float Cr_2O_3 %	Sink M %	Sink Cr_2O_3	Kod
+4.46	22.71	17.12	2.80	0.13	13.99	7.79	8.72	32.08	1.00
2.36 - 4.46	14.21	15.80	2.80	0.13	9.01	7.26	5.20	30.62	2.00
1.16 - 2.36	9.74	16.65	2.80	0.13	6.21	7.30	3.53	33.13	3.00
0.5 - 1.16	9.39	20.12	2.80	0.13	5.65	8.20	3.74	38.18	4.00
-0.5	43. 95	34.85	0.00	0.00	43.95	34.85	0.00	0.00	5.00
TOTAL	100.00	24.96	0.00	0.00	78.82	22.81	21.18	32.97	

Size range	Mass %	Cr_2O_3 %	SG	Ep	Float M %	Float Cr_2O_3 %	Sink M %	Sink Cr_2O_3	Kod
+4.46	22.71	17.12	2.80	0.13	13.99	7.79	8.72	32.08	1.00
2.36 - 4.46	14.21	15.80	2.80	0.14	9.03	7.48	5.18	30.30	2.00
1.16 - 2.36	9.74	16.65	2.80	0.14	6.23	7.54	3.51	32.80	3.00
0.5 - 1.16	9.39	20.12	2.80	0.14	5.68	8.52	3.71	37.90	4.00
-0.5	43.95	34.85	0.00	0.00	43.95	34.85	0.00	0.00	5.00
TOTAL	100.00	24.96	0.00	0.00	78.87	22.87	21.13	32.79	

Size range	Mass %	Cr_2O_3 %	SG	Ep	Float M %	Float Cr_2O_3 %	Sink M %	Sink Cr_2O_3	Kod
+4.46	22.71	17.12	2.80	0.13	13.99	7.79	8.72	32.08	1.00
2.36 - 4.46	14.21	15.80	2.85	0.14	10.13	9.33	4.08	31.86	2.00
1.16 - 2.36	9.74	16.65	2.90	0.15	7.87	12.29	1.87	34.99	3.00
0.5 - 1.16	9.39	20.12	2.90	0.15	7.35	14.68	2.04	39.73	4.00
-0.5	43.95	34.85	0.00	0.00	43.95	34.85	0.00	0.00	5.00
TOTAL	100.00	24.96	0.00	0.00	83.28	23.29	16.72	33.29	

Size range	Mass %	Cr_2O_3 %	SG	Ep	Float M %	Float Cr_2O_3 %	Sink M %	Sink Cr_2O_3	Kod
+4.46	22.71	17.12	2.80	0.13	13.99	7.79	8.72	32.08	1.00
2.36 - 4.46	14.21	15.80	2.90	0.13	11.56	11.79	2.65	33.27	2.00
1.16 - 2.36	9.74	16.65	2.90	0.15	7.87	12.29	1.87	34.99	3.00
0.5 - 1.16	9.39	20.12	2.90	0.15	7.35	14.68	2.04	39.73	4.00
-0.5	43.95	34.85	0.00	0.00	43.95	34.85	0.00	0.00	5.00
TOTAL	100.00	24.96	0.00	0.00	84.71	23.39	15.29	33.67	

Change separating conditions? Y/N
YES

Conclusion

The studies were carried out on low grade chromite ore which assumed that separation would be very difficult.

Based on the granulometric composition and the chromite distribution into siseranges it's determined that Cr_2O_3 content increases with the decrease of the size.

The application of the computer programme enables a quick quantitative calculation of the gravity concentration involving all available and acceptable equations which define the accomplishment of the technological operation.

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