1st Regional
APCOM Symposium

on

APPLICATIONS OF COMPUTERS AND OPERATIONS RESEARCH IN THE MINERAL INDUSTRIES

Editors

Prof. Dr. Mirko Perišić
Andrej Šubelj

Organized by:

Institute for Mining, Geotechnology and Environment
Ljubljana, Slovenia

In Cooperation with:

KBFI Budapest
Miskolci Egyetem
Montan Universität Leoben
Technische Universität Berlin
Universita di Bologna
Universita di Roma "La Sapienza"
University of Ljubljana, Dept. for Geology, Mining and Metallurgy
University of Zagreb

Bled, Slovenia, 20.- 23.6. 1994

COMPUTER TREATMENT OF GRAVITY CONCENTRATION FROM CHROMITE ORE

Prof. D-r BORIS KRSTEV
M-r MIRJANA GOLOMEOVA
M-r BLAGOJ GOLOMEOV

University "Sv. KIRIL & METODIJ" - Skopje
Faculty of Mining & Geology - Stip
Republic of Macedonia

INTRODUCTION

Heavy medium separation is applied to the pre-concentration of different minerals, it is the simpliest of all gravity process and has long been a standard laboratory method for separating minerals of different specific gravity. In principle, heavy mediums of suitable density are used and minerals lighter than the liquid medium float, while denser minerals than it sink.

The process is most widely applied when the density difference occurs at a coarse particle size, as separation efficiency decreases with size due to the slower rate of settling of the particles.

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.

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

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

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

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

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

$$z = Ep / \ln 0.5 \quad (5)$$

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

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

where x_o , y_o , 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 shown on the Table 2. The performance of the chromite ore heavy medium separation is evaluated in Table 3.

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	59.1	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	

HEAVY LIQUID MEDIUM = $C_2Br_4 + CCl_4$

Specific gravity fraction	Feed m (%)	Cr_2O_3 (%)	Floats Σm (%)	ΣCr_2O_3	Sinks Σm (%)	ΣCr_2O_3
- 2.40	0.79	0.44	0.79	0.44	100.00	17.59
2.40 - 2.50	17.32	1.44	18.11	1.42	99.20	17.73
2.50 - 2.60	20.47	3.80	38.58	2.68	81.88	21.18
2.60 - 2.70	13.70	8.44	52.28	4.19	61.41	26.97
2.70 - 2.80	7.24	12.21	59.52	5.17	47.71	32.29
2.80 - 2.90	8.20	16.66	67.71	6.56	40.47	35.88
+ 2.90	32.28	40.76	100.00	17.59	32.28	40.76
Σ	100.00	17.59				

COMPUTER PROGRAM FOR GRAVITY CONCENTRATION

In order to interpret gravity concentration of chromite ore and for predicting the performance of heavy media circuit, using equations (2 - 5), was developed computer program about evaluation of heavy liquid data.

DATA CHECK

Density	Weight	Assay	Code
2.40	0.79	0.44	1.00
2.50	17.32	1.46	2.00
2.60	20.47	3.80	3.00
2.70	13.70	8.44	4.00
2.80	7.24	12.21	5.00
2.90	8.20	16.66	6.00
+2.90	32.28	40.76	7.00

If data correct, press RETURN
If incorrect, input ERROR ?

Density	Weight %	Assay	Distn %	Weight % Cumulative	Distn % Cumulative
2.40	0.79	0.44	0.02	0.79	0.02
2.50	17.32	1.46	1.44	18.11	1.46
2.60	20.47	3.80	4.42	38.58	5.88
2.70	13.70	8.44	6.57	52.28	12.45
2.80	7.24	12.21	5.02	59.52	17.48
2.90	8.20	16.66	7.76	67.72	25.23
+2.90	32.28	40.76	74.77	100.00	100.00

If partition date for vessel is known, then input "Y". If date is not known, input "N",
then input values for separating density and Ecart probable Ep ?
N
Separating density ? 2.75

Ecart probable ? 0.13

Predicted performance at S.G. 2.75
and Ep of 0.13

	Weight %	Assay	Distn%
FLOATS	49.01	5.17	14.40
SINKS	50.99	29.54	85.60

Do You wish to input other values ? Y N
If "N" return to heavy liquid balance ?

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.

REFERENCES

1. B. A. WILLS - Mineral Processing Technology, Pergamon Press, Oxford, 1989
2. Р. ИГНАТОВИЋ – Теорија гравитацијске концентрације минералних сировина, Савремена администрација, Београд, 1980
3. Т. Г. ФОМЕНКО – Гравитационнъіе процессъі обогащения полезнъіх ископаемъіх. Недра, Москва, 1966
4. KASO – On The Theory of Partition Curve and Application to Coal Preparation and Mineral Dressing, Memorys of the Faculty of Engineering, Kyushu University, vol 17, N° 1, 1957
5. H. KODOMA – The Theory of Separation in a Jig Machine, Coliery Engineering, 391, vol. 33, 1956
6. A. GODEN – Principles of Mineral Dressing, mc Graw - Hill Book, Co lg, New York, 1939
7. B. KRSTEV, B. GOLOMEOV – Basic Computer Program ciščenja rovnog uglja sitnih klasa rudnika Suvodol - Makedonija, XII Yu - Simpozium, Zbornik radova, Tuzla, 1989