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Beneficiation of Madaka Manganese Ore by Jigging

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Abstract

This study investigates the beneficiation of Madaka manganese ore by jigging. Manganese ore was obtained from Madaka mining site, Niger state, Nigeria. The ore contains medium amount of manganese (28.23% MnO_2) and iron ore (17.91% Fe_2O_3) as revealed by chemical analysis was crushed using the laboratory jaw crusher and ground in a laboratory ball mill. Particle size analysis was carried out over the range of +355 and +80 in 7 different mesh sizes, and the ore was jigged. The operating variable used to determine the effectiveness of recovery is the particle size and was assessed by determining the percentage of MnO_2 in the underflow and overflow using x-ray fluorescence (XRF). Optimum MnO_2 recovery of 73.71% was achieved at particle size 125μm which also indicate the liberation size of the ore.

Keyword: Manganese, Analysis, Particle size, Recovery.

Introduction

The present knowledge of manganese as one of the strategic metallic elements was recognized by a Swedish Chemist in 1974 and at present the metal is indispensable in the manufacture of steel, where it is used in the form of ferro - manganese and also as a direct feed to the blast furnace.

More than 90% of the world's mined manganese ends up in steel products. On average, one tonne of steel contains about 7.5kg of manganese (Roy, 1981). Manganese serves two functions in steel making first as an additive and second as an alloy (Anon, 2006).

It may be pointed out that steel, no matter what grade or type, cannot be made and shaped without the appropriate amount of manganese in it, and there is no satisfactory substitute for manganese. It is ultimately consumed in the production of iron and steel, either directly as ore in the blast furnace or as ferro-manganese and metal in steel making.

Manganese ore is mined by both underground and surface methods depending upon the geological setting of the deposit. The manganese ore is usually hand sorted in lump ore and fines.

Since the goal of every mineral processing operation is to effectively separate the valuable material from the gangue with minimum metal loss in tailings, the need to develop and employ a sustainable, effective and relatively economical method of separation is imperative. The concentration of the valuable minerals from the gangue involves exploitation of the differences in the mineral properties of the ore after effective comminution (Akande and Olaleye, 2000).

Reports from Geological Survey of Nigeria and National Steel Raw Materials Exploration Agency showed that Nigeria is blessed with large reserves of proven and unproven manganese deposit. However, the local industries have continued to depend on importation of manganese for all its required consumption either as metal or its alloys. This is because the local Manganese deposits are of low grade and require beneficiation before they could be used. Madaka manganese ore beneficiation was studied using the jigging method and the effect of particle size as a variable on the recovery of manganese using the laboratory jig was investigated.

Materials and Methods

The bulk ore used in this study was obtained from Madaka mine, Niger state.

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Its chemical composition as revealed by x-ray fluorescence (XRF) is shown in Table 1. The ore was broken into sizes that could be fed into the jaw crusher using a sledge hammer. Crushing was carried out in a laboratory jaw crusher and ground in a laboratory ball mill. The ore sieving was carried out using sieve shaker. 200g of the ore was introduced into the nest of the ASTM sieves and the timer was set at 15 minutes. The sieves were taken apart after the stipulated time and the amount of material retained on each sieve was weighed and recorded. Table 2 shows the composition of the material retained on each sieve.

200 grams of the ore of the same size from the product of the sieve analysis was stored in a tray to form the feed for the jigging operation. The jig machine was rinsed with clean water to avoid any contamination with other materials. The spigot hutch compartment was placed properly with the rubber cork and filled with water to cover the ragging in the feed compartment. The feed was fed into the jig and the jigging operation was allowed for 5 minutes. At the end of each jigging operation, the spigot of the hutch compartment was opened and the product was collected as the underflow. The overflow materials left in the feeding compartment were scooped and washed out. The two products (underflow and overflow) were dewatered, dried, weighed and recorded. The experiments were repeated with varying particle sizes.

The amount of manganese ore in each of the underflow and overflow was evaluated by determining the percentages of manganese in the samples using x-ray fluorescence (XRF).

Results and Discussion

The result of the chemical analysis of Madaka manganese ore is presented in Table 1. From the result shown in the table, it is seen that the Madaka ore assays 28.23% of manganese oxide and can be classified to be of medium grade when compared with other deposits from Australia, Brazil and Gabon.

Table 1: Chemical Composition of Madaka Managanese Ore

Mineral	Al_2O_3	SiO_2	P_2O_5	K_2O	CaO	TiO_2	MnO_2	Fe_2O_3	As_2O_3
Composition	11.50	33.92	1.27	1.97	1.09	0.11	28.23	17.91	0.99

Size Analysis

Table 2 shows the results obtained from the particle size analysis of the ore. It can be observed from table 2 that the smaller the aperture of the sieves, the lower the weight percentage of the material retained. The aperture range of 355µm has the most retained weight percent which is followed by 180µm and then 250µm respectively.

Table 2: Particle Size Analysis of Manganese Ore

Sieve Size Range (µm)	Normal Aperture (µm)	Weight Retained (g)	Percentage Weight Retained (g)	Cumulative Weight Retained (g)	Cumulative Weights Passing (g)	Assay of Mn_2O %
+355	355	148.80	29.76	29.76	99.99	23.12
-355 + 250	250	76.40	15.28	45.04	70.24	25.06
-250 + 180	180	81.80	16.36	61.40	54.96	26.39
-180 + 125	125	75.90	15.18	76.58	38.60	24.34
-125 + 90	90	59.72	11.94	88.52	23.42	21.99
-90 + 80	80	40.32	8.06	96.58	11.48	21.06
-80 + 63	63	17.06	3.41	99.99	3.41	

The coarse component of the ore is quite significant as more than 50% weight falls within sieve size aperture 355 - 125μm. Also, the various size fractions obtained from the particle size analysis were subjected to chemical analysis. Sieve size 180μm gives the highest assay of MnO_2 as 26.39%.

Table 3: Jigging Operation Result

Sieve Size μm	Feed (g)	Underflow (U) Weight (g)	Underflow (U) Assay (%)	Overflow (O) Weight (g)	Overflow (O) Assay (%)	Losses 200-(u+O)	Recovery (%) $C(f-t)/F(c-t)$
250	200	162.5	35.90	31.10	21.94	6.40	60.30
150	200	135.4	41.02	61.00	18.34	3.60	66.78
125	200	110.0	38.60	85.00	18.01	5.00	73.71
90	200	99.7	33.54	96.00	16.20	4.30	54.64

The results, as shown in Table 3, revealed that manganese ore concentrate (underflow) was effectively separated from the tailings (overflow), which are essentially quartz and iron. From the results, it was observed that the overflow, i.e. the tailings still have an appreciable percentage of manganese. The effect of the particle size on the recovery of manganese is also shown in table 3. The highest recovery was achieved at 125μm to be 73.71%.

Conclusion

In early years, Nigeria had very little domestic use for manganese ore. In view of the changed situation, namely the increasing demand by the growing domestic production of steel coupled with limited reserves, it is considered advisable to adopt beneficiation process for manganese ore to achieve higher recovery of saleable ore.

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