The 57th International October Conference on Mining and Metallurgy
05 - 07 October 2026, Bor Lake, Serbia
https://ioc.irmbor.co.rs

DOI: 10.5937/IOC26117J Original Scientific Paper-Mineral Processing

CHARACTERIZATION OF COMPLEX BAUXITE ORE - PART I

Ivana Jovanović[1a], Dragan Milanović[1b], Vesna Conić[1c], Dejan Bugarin[1d], Miloš Janošević[1e], Gordana Deljak[2a], David Radovac[2b]

[1]Mining and Metallurgy Institute Bor, Alberta Ajnštajna 1, 19210 Bor, Serbia
[2]Bauxite mines o.d.d. Jajce, Divičani bb, Jajce, 70101, Bosnia and Herzegovina

[1a] ivana.jovanovic@irmbor.co.rs, https://orcid.org/0000-0002-7450-6632
[1b] dragan.milanovic@irmbor.co.rs, https://orcid.org/0000-0002-5589-9127
[1c] vesna.conic@irmbor.co.rs, https://orcid.org/0000-0002-4268-3626
[1d] dejan.bugarin@irmbor.co.rs, https://orcid.org/0000-0002-9103-4614
[1e] milos.janosevic@irmbor.co.rs, https://orcid.org/0000-0002-0818-1235
[2a] goga_rajic@hotmail.com
[2b] david.radovac@rgn.unizg.hr

Abstract

This paper presents the results of the granulometric characterization of a complex, high-iron bauxite ore using dry sieve analysis. The research focuses on the particle size distribution of three distinct material categories: the coarse stockpile class (-300+0 mm), the intermediate stockpile class (-8+0 mm), and a fine composite class (-4+0 mm), evaluated via series of laboratory sieves. The experimental results indicate that the coarse stockpile ore is dominated by large fragments, with approximately 90% of its total mass concentrated above 50 mm. In contrast, the intermediate stockpile class demonstrates a significantly more balanced and uniform particle size distribution. Sieve analysis of the fine composite class (-4+0 mm) confirms a highly uniform material distribution throughout the lower millimeter fractions. These structural parameters and physical size characteristics establish the necessary baseline data required for downstream mineral processing and separation designs.

***Keywords**: Bauxite ore; Dry sieve analysis; Particle size distribution;*

1. INTRODUCTION

Bauxite remains the primary and global mineral source for alumina and aluminum production, making its processing vital for modern metallurgical industries [1]. However, the progressive depletion of high-grade deposits shifts industrial focus toward complex, low-grade, and highly heterogeneous ore bodies. These alternative raw materials typically exhibit intricate mineral textures and fine grain sizes, presenting significant technical challenges during downstream concentration and chemical treatment.

To overcome these barriers, physical pre-treatment and comminution represent the initial engineering steps in mineral processing flowsheets [2]. The efficiency of subsequent metallurgical operations directly correlates with the success of initial ore crushing, grinding, and sizing techniques. Within this framework, particle size distribution determines the variations in mass yield through different size classes, which significantly affects material transport and mill capacity.

Particle size analysis serves as a fundamental diagnostic tool for evaluating the physical properties of the ore and its behavior during crushing [3]. This characterization identifies potential trends of selective grinding, where certain mineral phases naturally separate into distinct size classes. Quantifying these relationships between particle size and mass is

essential for predicting the degree of mineral liberation and defining the optimal characteristics of the feed for precise separation processes. Consequently, a detailed sieve analysis forms the necessary basis for evaluating the structural characteristics of the raw bauxite matrix before complex chemical upgrading.

2. EXPERIMENTAL

Experimental procedure is performed on technological samples of complex high-iron bauxite ore from a specific locality. Selected samples from the stockpile with size –300+0 mm and –8+0 mm were transported to MMI Bor. For the research purposes, bauxite ore was crushed down to –15 mm, mixed, and after that obtained composite is classified to the particle size classes –15+4 mm and –4+0 mm. The particle size distribution of the samples was determined by dry sieving on a standard calibrated series of sieves of the "IMPACT TEST" type. Particle size analysis was performed for class –300+0 mm, –8+0 mm and –4+0 mm (see Figure 1)



Figure 1. *Dry sieving of class –300+0 mm (left), –8+0 mm (middle) and –4+0 mm (right)*

3. RESULTS AND DISCUSSION

The results of the particle size analysis are presented in Tables 1-3 and Figures 2-4.

Table 1. *Particle size distribution of class –300+0 mm obtained by dry sieving*

Size class, mm	M, %	R, %	D, %
-300.0+150.0	9.41	9.41	100.00
-150.0+100.0	21.92	31.33	90.59
-100.0+75.0	28.57	59.90	68.67
-75.0+50.0	30.79	90.69	40.10
-50.0+37.5	5.23	95.92	9.31
-37.5+28.0	0.41	96.33	4.08
-28.0+20.0	0.45	96.78	3.67
-20.0+16.0	0.23	97.01	3.22
-16.0+11.2	0.38	97.39	2.99
-11.2+8.0	0.34	97.73	2.61
-8.00+5.60	0.30	98.03	2.27
-5.60+4.00	0.20	98.23	1.97
-4.00+3.15	0.15	98.38	1.77
-3.15+2.80	0.38	98.76	1.62
-2.80+2.00	0.19	98.95	1.24
-2.00+1.40	0.11	99.06	1.05
-1.40+1.00	0.11	99.17	0.94
-1.00+0.00	0.83	100.00	0.83
Σ	100		

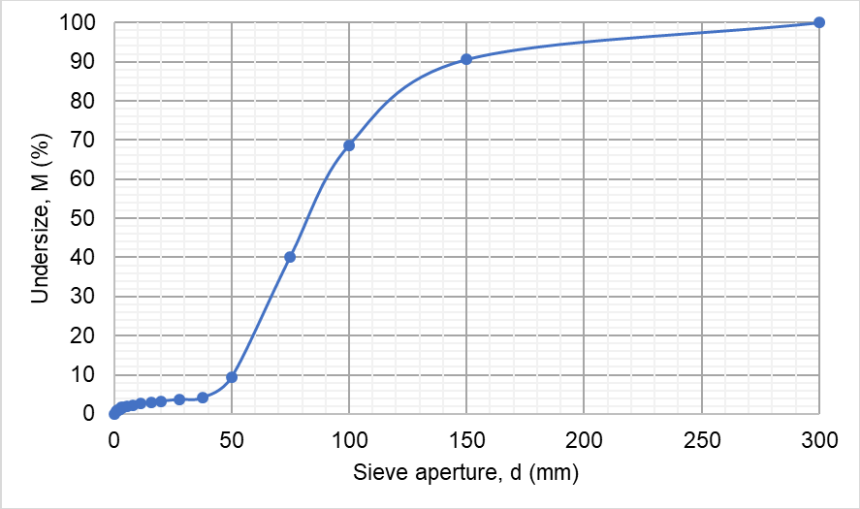


Figure 2. *Particle size distribution undersize curve of class –300+0 mm*

Table 2. *Particle size distribution of class –8+0 mm obtained by dry sieving*

Size class, mm	M, %	R, %	D, %
-8.00+6.30	21.56	21.56	100.00
-6.30+3.35	18.16	39.72	78.44
-3.35+2.36	10.38	50.10	60.28
-2.36+1.18	16.47	66.57	49.90
-1.18+0.85	5.15	71.72	33.43
-0.85+0.60	6.02	77.74	28.28
-0.6+0.425	4.28	82.02	22.26
-0.425+0.300	3.74	85.76	17.98
-0.300+0.212	4.11	89.87	14.24
-0.212+0.150	2.01	91.88	10.13
-0.150+0.106	3.20	95.08	8.12
-0.106+0.075	2.50	97.58	4.92
-0.075+0.053	1.03	98.61	2.42
-0.053+0.038	0.88	99.49	1.39
-0.038+0.020	0.32	99.81	0.51
-0.020+0.0	0.19	100.00	0.19
Σ	100		

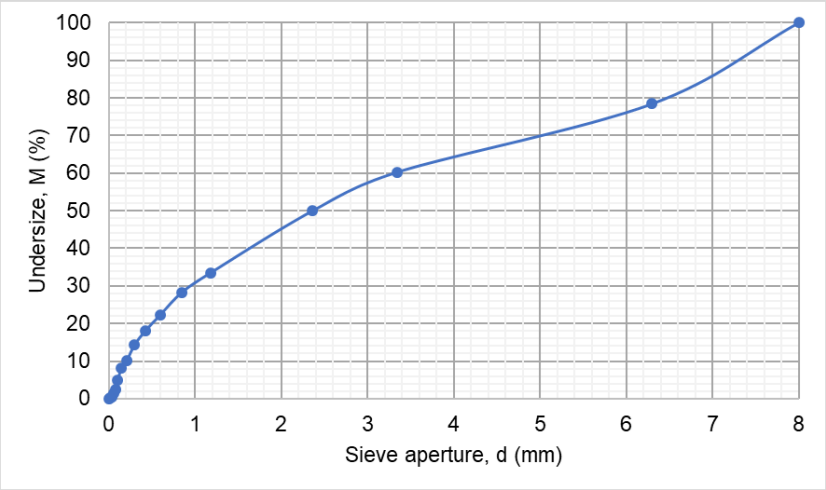


Figure 3. *Particle size distribution undersize curve of class –8+0 mm*

Table 2. *Particle size distribution of class –8+0 mm obtained by dry sieving*

Size class, mm	M, %	R, %	D, %
-4.00+3.35	4.75	4.75	100.00
-3.35+2.36	10.20	14.95	95.25
-2.36+1.18	22.30	37.25	85.05
-1.18+0.85	8.25	45.50	62.75
-0.85+0.6	11.10	56.60	54.50
-0.6+0.425	8.25	64.85	43.40
-0.425+0.300	8.65	73.50	35.15
-0.300+0.212	4.50	78.00	26.50
-0.212+0.150	5.10	83.10	22.00
-0.150+0.106	4.40	87.50	16.90
-0.106+0.075	3.15	90.65	12.50
-0.075+0.053	3.25	93.90	9.35
-0.053+0.038	2.15	96.05	6.10
-0.020+0.0	3.95	100.00	3.95
Σ	100		

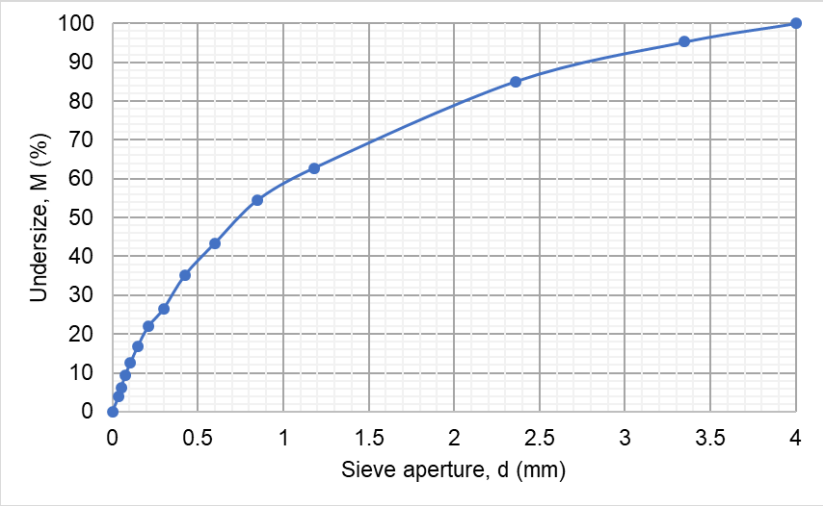


Figure 4. *Particle size distribution undersize curve of class –4+0 mm*

As can be seen from the Tables 1-3 and Figures 2-4, particle size distribution varies significantly across the analyzed classes. For the coarse stockpile class (–300+0 mm), there is a high proportion of large classes in the sample, about 90% of the mass is larger than 50 mm, and d_{50} is around 8.2 mm. The intermediate stockpile class (–8+0 mm) has a more uniform size distribution compared to the coarse class, with d_{50} around 2.4 mm. Finally, for the fine composite class (–4+0 mm), it can be seen that the particle size distribution is uniform and d_{50} is around 0.7 mm.

4. CONCLUSION

The experimental dry screening analysis shows significant variations in the granulometric composition across the tested bauxite ore streams. The coarse stockpile shows a non-uniform structure with a dominant share of large blocks, which confirms the necessity of primary industrial crushing at the very reception into the plant in order to prevent blockages in transport. In contrast, mechanical processing to the level of the intermediate stockpile yields a far more balanced and uniform grain size trend, which provides the material stability necessary for the efficient operation of belt conveyors. Finally, the classification of the fine composite stream achieves a consistent spectrum of sizes in the lower millimeter fractions, thereby ensuring a homogeneous composition of the starting raw material for direct industrial application.

ACKNOWLEDGEMENTS

This work was supported by the European Union's Horizon Europe research and innovation programme under grant agreement No. 101177746 (SCIMIN-CRM project).

We thank the Ministry of Science, Technological Development and Innovation of the Republic of Serbia, Agreement on the implementation and financing of scientific

research work of the National Research Institute in 2026, No. 451-03-33/2026-03/ 200052 for support.

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