Sustainable Upgrading of Bauxite and Valorization of Bauxite Tailings

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https://doi.org/10.71659/icsoba2025-bx018

Abstract

Global bauxite production in 2022 was reported at approximately 400 million tonnes per year, with more than half originating from Australia and Guinea. A lot of other Bauxite reserves need an upgrading to meet the requirements regarding the main ingredients of Al_2O_3 and SiO_2, to make it suitable for the Alumina refinery extraction process. Therefore, upgrading by washing and classification processes could be the solution to disintegrate and to separate unwanted impurities. Due to the typical particle size distribution (PSD) of such bauxite deposits, it is essential to identify the valuable fractions and ensure their specific liberation and separation. The main objectives of the upgrading process include designing the process route, selecting and sizing appropriate equipment, and developing the overall plant layout.

A distinction should be made between bauxite tailings, which originate from washing plants, and bauxite residues, which are the residual red mud produced by alumina refineries. Additionally, the valorization of tailings from legacy washing plants could be considered to recover valuable fractions, contributing to a more sustainable use of resources. Because of limited or outdated classification techniques, older bauxite washing plants mainly targeted coarse fractions (> 4 mm). However, studies of legacy tailings dams have shown that significant amounts of material still meet today's quality standards. The challenge now is to define the optimal cut size and design a suitable process route to recover these valuable resources still present in those legacy tailings dams.

For decades, AKW Equipment + Process Design has been actively involved in bauxite washing and valorization, supplying a wide range of proprietary equipment as well as turnkey processing plants. Thanks to our state-of-the-art in-house technical laboratory, we are able to conduct test work on original material samples. Based on these test results, we define the optimal process flow, which then serves as the foundation for the plant design.

Keywords: Upgrading of bauxite, Bauxite quality demand, Bauxite tailings valorization.

1. General Information on Bauxite

1.1 Resources

Bauxite is a naturally occurring, heterogeneous material composed primarily of one or more aluminum hydroxide minerals, plus various combinations of silica, iron oxide, titania, aluminosilicate, and other impurities in minor or trace amounts.

Over the last years, due to the general decrease in the availability of good bauxite raw material quality, the need and investigations for new bauxite valorization opportunities have gained momentum. This is especially true for bauxite tailings, which, in some cases, offer a powerful alternative to newly mined bauxite.

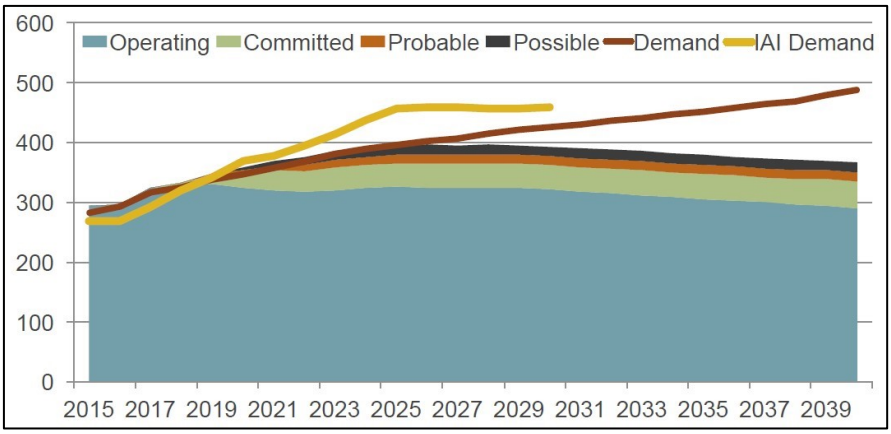

Figure 1. Current & predicated worldwide bauxite supply & demand, 2012-2039 (Mt) [1].

There are approx. 80 bauxite mines listed worldwide. The largest 8 ones, with capacities above 10 up to 25 Mt/y, are mainly located in Australia, Brazil, Guinea and Indonesia. Most of the bauxite mines have capacities below 5 Mt/y down to under 1 Mt/y.

Table 1. Bauxite world production [2]

TABLE 11

BAUXITE: WORLD PRODUCTION, BY COUNTRY OR LOCALITY[1]

(Thousand metric tons)

Country or locality	2018	2019	2020	2021	2022
Australia	95.948	105.544	103.627	103.056	102.290
Bosnia and Herzegovina	803	934	688	725 r	700 e
Brazil, dry basis	32.377	31.938	32.898	33.000 e	30.000 e
China	77.170	73.320 r	62.800 r, e	86.000 r, e	90.000 e
Cote d'Ivoire e	400	750	700	700	700
Croatia	12	14	14	14	10 e
Dominican Republic	--	--	9	89	90 e
Fiji	60 e	--	--	--	-- e
Ghana	1.011	1.116	1.162	839 r	800 e
Greece[2]	1.559	1.379 r	1.429 r	1.227 r	1.200 e
Guinea, dry basis e, 2	57.000	67.000	86.000	82.000 r	100.000
Guyana, dry basis	1.926	1.920	595	619	706
Hungary	5	--	--	-- e	-- e
India	23.229	22.321	19.988	22.136 r	24.000 e
Indonesia	13.243	16.593	20.800 e	21.000 e	21.000 e
Iran[2]	805	1.163	1.200 e	1.100 r, e	572
Jamaica, dry basis	10.058	9.022	7.546	5.950	4.365
Kazakhstan	5.700	4.118	4.058	4.370	4.400
Malaysia	590	901	595	624 e	600 e
Montenegro	468	775	897	542 r	442
Mozambique	10	8	6	8 r	8 e
Pakistan	121	58	105 r	97 r	45 e
Russia	5.651	5.574	5.570	5.679	5.780
Saudi Arabia	4.731	5.031	4.946	4.781	4.800 e
Sierra Leone	1.938	1.884	1.342	1.397	910
Solomon Islands	1.609	1.161	842	-- e	-- e
Tanzania	11	--	26	38 r	40 e
Turkey	1.000 e	2.255 r	2.400 r	2.765 r	2.800 e
United States	W	W	W	W	W
Venezuela	--	--	250 e	250 e	250 e
Vietnam	3.500 e	3.350 e	3.580	3.670 r, e	3.860 e
Total	341.000	358.000 r	364.000 r	383.000 r	400.000

eEstimated. rRevised. W Withheld to avoid disclosing company propriety data. -- Zero.

[1]Table includes data available through June 21, 2023. All data are reported unless otherwise noted, totals may include estimated data. Totals and estimated data are rounded to no more than three significant digits; may not add to totals shown.

[2]Dry bauxite equivalent of crude ore.

Figure 17. Processing plant stock tailings. The box feeder on the right side will be filled by wheel loader with the bulky stock tailings material and the same vertical process arrangement as the fresh tailings.

The implementation of bauxite tailings washing units has delivered remarkable results, marking a significant advancement in resource efficiency and sustainability:

- 50% increase in valuable product recovery from the bauxite washing plant has extended the operational life of the deposit while substantially reducing tailings discharge.
- 50% recovery of valuable material from existing tailings has unlocked additional product capacity and enabled the productive reuse of legacy tailings dams.

These achievements not only enhance the economic performance of the operation but also contribute meaningfully to environmental stewardship and long-term resource management.

6. References

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