10TH INTERNATIONAL IBAAS CONFERENCE AND EXHIBITION

IBAAS - JNARDDC 2022

SUSTAINABILITY CHALLENGES OF BAUXITE, ALUMINA AND ALUMINIUM INDUSTRY

SOUVENIR

SEPTEMBER 14-17, 2022

COURTYARD MARRIOTT, RAIPUR, INDIA

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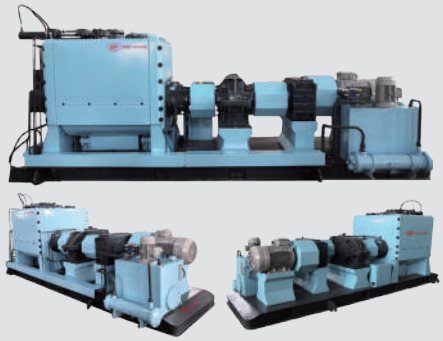
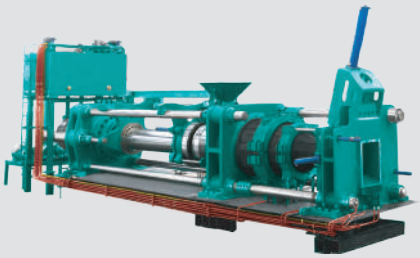
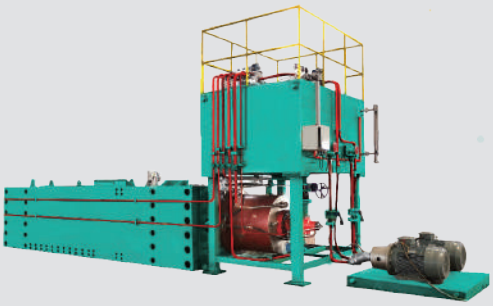


Vibration Compactor for Green Anodes

Extrusion Press for Graphite Electrodes



Hydraulic Crusher for Carbon Products



Anode Blocks Robotic Cleaning System

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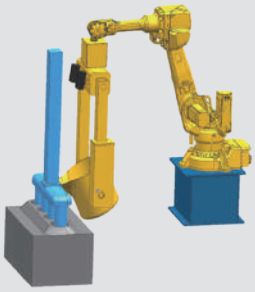

Graphite Electrode Cleaning System

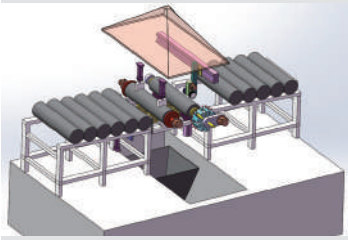

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TABLE OF CONTENTS

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WELCOME NOTE

On behalf of the organizing committee, it is our pleasure to welcome you to the **10th IBAAS International Conference & Exhibition** (IBAAS-JNARDDC-2022) on ***"Sustainability Challenges of Bauxite, Alumina & Aluminium Industry"*** being held in Raipur, India during September 14-17, 2022 in association with Jawaharlal Nehru Aluminium Research Development & Design Centre (JNARDDC) and Aluminium Stewardship Initiative (ASI).

About 68 Abstracts of technical papers have been received from all over the world for this mega aluminium event. Several special technical sessions are planned for the10th IBAAS International Conference & Exhibition under the following categories:

1.0 Bauxite and Non-Metallurgical Bauxite Session
2.0 Alumina and Special Alumina
3.0 Aluminium Smelting & Downstream
4.0 Special Session on Sustainability by Aluminium Stewardship Initiative
5.0 Brainstorming Session on Non-Ferrous Metal Recycling in India by JNARDDC

We welcome you to this mega Aluminium event in India and are confident that you all will enjoy the stimulating technical sessions and will benefit from this opportunity to interact with bauxite, alumina and aluminium industry leaders, experts and professionals from all over the world.

Best Regards,
Organizing Committee of IBAAS-2022

IBAAS PROFILE

International Bauxite Alumina & Aluminium Society (IBAAS)

IBAAS is an organization formed by professionals active in various fields of Aluminium industry, with its roots in India/Asia. The objectives of this society are as follows:

- To provide platform for aluminium industry professionals to interact and work together with common goals for development.
- To organise annual and bi-annual workshop, seminar and conferences in association with primary aluminium producers and/or R&D centres.
- To represent primary aluminium industry as an independent organisation.
- To promote latest technology and advertise products and equipment.
- To publish, papers, monographs and books to highlight latest achievements in the field.
- To facilitate technology transfer and compile a list of experts available in the field.

The Society was established in 2012 and is committed to promote the development of Bauxite, Alumina and Aluminium industry in the World. The Society has since then organized nine International events in India, China and Guinea.

IBAAS-2012: First International symposium of IBAAS on the topic "Bauxite, Alumina and Aluminium Industry of Asia – Vision 2020", December 3-5, 2012 in association with JNARDDC (Jawaharlal Nehru Aluminium Research Development & Design Centre) in Nagpur, India with a special emphasize on non-metallurgical bauxites and alumina products.

IBAAS-2013: Second International symposium of IBAAS on the topic "Present Status and Future Prospects of Bauxite- Alumina and Aluminium Industry of the World, with Special Reference to China", November 28-30, 2013 in association with CHALIECO (China Aluminum International Engineering Co., Ltd.) and ANTAIKE (Beijing Antaike Information Development Co., Ltd) in Nanning, Guangxi, China.

IBAAS-2014: Third International symposium of IBAAS on the topic "Technological Improvements & Market Developments in Aluminium Industry with Special Reference to Value Added Products of Bauxite, Alumina and Aluminium" in Visakhapatnam, India during November 27-29, 2014.

IBAAS-2015: Fourth International symposium of IBAAS on the topic "The Development and Future of Aluminium Industry in China - Reality and Dream" was organized in Suzhou, China during November 25-27, 2015 in association with CHALIECO (China Aluminum International Engineering Corporation Limited) and SINR (Suzhou Research Institute for Nonferrous Metals).

IBAAS PROFILE

IBAAS-2016: The 5th IBAAS symposium on the topic "Aluminium Industry-The Evolving Asia-Pacific Story" was held successfully in Goa India during September 26 – 28, 2016. This International Symposium was jointly organized with The Indian Institute of Metals (IIM) and attracted more than 200 delegates from all over the world. The conference was organized closely in association with Indian Primary Aluminium Producers like HINDALCO, VEDANTA and NALCO.

IBAAS-2017: The sixth International symposium of IBAAS on the topic 'Sustainable Development of Bauxite & Alumina Industry in Guinea' was organized in Conakry, Guinea during September 21-22, 2017 in collaboration with CAMEN Resources. This was the first Bauxite-Alumina conference in Guinea and widely appreciated by participating companies, delegates and Government of Guinea.

IBAAS-2018: The seventh International symposium of IBAAS on the topic 'Indian Aluminium Industry Status, Strategies & Way Forward for Accelerated Growth' was held in Mumbai, India during September 5-7, 2018. This International Symposium was organised in association with IIM (The Indian Institute of Metals), AAI (Aluminium Association of India), JNARDDC (Jawaharlal Nehru Aluminium Research Development & Design Centre) and ABSTCPL (The Aditya Birla Science & Technology Company Private Limited).

IBAAS-2019: The eighth International symposium of IBAAS on the topic 'Technological Advances in Alumina, Aluminium Smelter, Downstream Fabrication, Energy Conservation, Environmental Protection and Smart Manufacturing with Special Reference to China' was organized in Guiyang, China during September 4-6, 2019 in association with GAMI (Guiyang Aluminium Magnesium Design & Research Institute Co., Ltd. This was third successful Aluminium conference and exhibition in China.

IBAAS-2020: The ninth International conference of IBAAS on the topic 'Sustainability Challenges of Bauxite, Alumina & Aluminium Industry' was organized online during November 4-6, 2020 from the premises of JNARDDC (Jawaharlal Nehru Aluminium Research Development & Design Centre).

The above nine International events were highly successful and evoked wide interest of Bauxite-Alumina & Aluminium industry and experts in the IBAAS symposium and conferences. In continuation of above nine conferences, this year IBAAS is organizing tenth International conference & exhibition (IBAAS-2022) in Raipur, India during September 14-17, 2022.

For further details please visit the IBAAS website ***www.ibaas.info***

ASSOCIATED ORGANIZERS

Aluminium Stewardship Initiative Ltd was incorporated as a non-profit public company limited by guarantee in Australia in June 2015 and is a Registered Charity. It has a global membership of more than 100 organisations, comprised of companies throughout the aluminium value chain, civil society organisations, associations and other supporters. ASI is also a member of the ISEAL Alliance, the global membership association for credible sustainability standards.

Jawaharlal Nehru Aluminium Research Development and Design Centre (JNARDDC) is an autonomous body under Ministry of Mines, Govt. of India. It is a "Centre of Excellence" set up in 1989 as a joint project by Ministry of Mines, Government of India and United Nations Development Program and fully functional since 1996. It was set up with a vision to create a state-of-the-art research institute for the development of technologies and provide services to both primary and secondary aluminium industries with a special emphasis on environmental sustenance, energy and material conservation.

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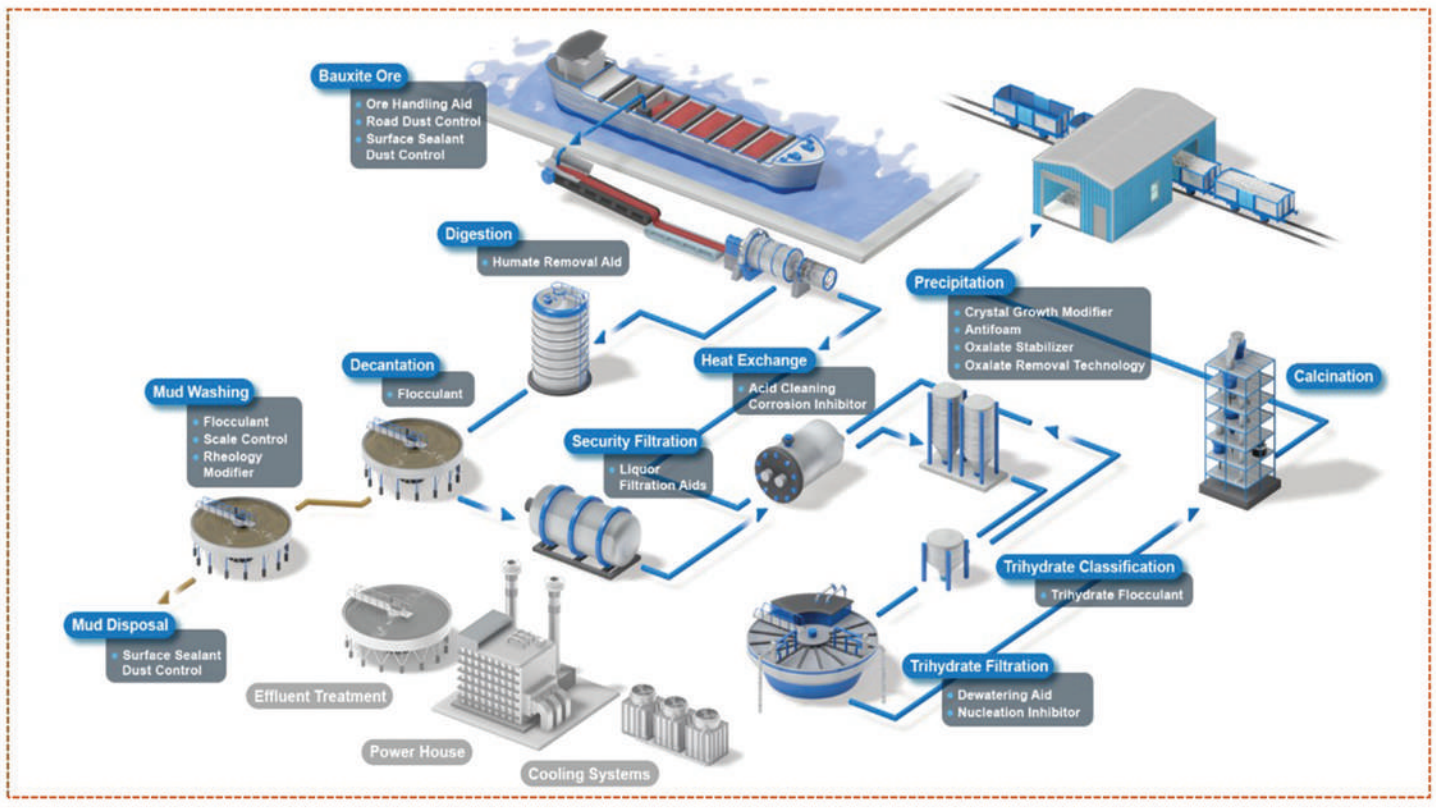

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Untapped Bauxite Resource and Strategic Outlook for Growth

Bijesh Jha
President (Mines) & Bauxite Vertical Head
Hindalco Industries Limited
Email: bijesh.jha@adityabirla.com

Abstract

Bauxite is the world's main source of aluminium and gallium. The overall resource position of bauxite in India is over 3 billion tonnes. As of 2020, India had bauxite reserves of around 660 million metric tonnes. India (26 MT production) ranks 5th Bauxite producing country in the world after, Australia (105 MT), China (68 MT), Guinea (64 MT), Brazil (30 MT). The mammoth mineral resources and their exploitation have always remained as the backbone of the Indian metal sector including downstream production. If strategically nurtured, the contribution of the mineral sector to the nation's GDP can be boosted from the current 1.75% to 6-8%, while the government has envisioned 2.5%. The Govt. of India's $5 trillion aspiring growth plan vision, Self-reliant India and the enterprising mega infrastructure projects will seek massive aluminium consumption, among other commodities. Future growth rate is likely to be high in transport and construction industries, with stress for infrastructure, power sector also likely to grow.

Currently, India imports bauxite of worth 390 Crores and Bauxite import has increased by 300 percent in past six years as per data published in Import-Export Databank, Ministry of Commerce, Government of India and has caused an estimated forex loss of over $400 million dollars in the last five years alone. And this forex loss will continue unabated unless India can successfully auction bauxite mine leases and increase production of existing mines by at least 50%. In 2020, the export volume of bauxite from India was around 0.21 MT. This was the lowest volume exported since 2012. It is alarming to see that over the last five years, despite the steady rise in demand and consumption of aluminium, there has been no successful auction of any metallurgical grade bauxite mine, since the inception of the MMDR Act 2015. The unviable method of determination of average sale price (ASP) of metallurgical grade bauxite that is calculated from the selling price of the end-product, i.e., aluminium. For India to achieve its manufacturing vision, a multi-fold growth in bauxite production from the current 20-22 million tonnes to 48 million tonnes per year is needed to meet the growing domestic requirement. Bauxite is used in chemical industry, refractory brocks, abrasive, cement, steel, and petroleum, apart from producing aluminium. So, Bauxite can be widely used in the sectors as well. Bauxite mining activities have a multiplier effect on livelihood opportunities in the remote and impoverished regions of the country, and the sector could be the key to bringing transformational change and employment avenues in various districts of the country that are seeing migrants returning to their home states, while ensuring India becomes a global manufacturing powerhouse.

This paper will discuss regarding the potential of uncapped Bauxite Resources of India, Government support and other statutory requirements favourable for bauxite production and economic development of the country through sustainable Bauxite production enhancement.

Keywords: Untapped Bauxite Resource, MMDR Act 2015, $5 trillion aspiring growth plan, Aluminium, Future strategy.

How Cut-off Grade Changes the Configuration of Bauxite Ore Body, Resources, Grades and Contribute to Economic Valuation of a Project?

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[1]General Manager, Sierra Mineral Holdings 1 Ltd. (Vimetco)
[2]Bauxite Alumina Consultant, Mineral Information & Development Centre (I) Pvt. Ltd.
[3]Technical Consultant

Abstract

Mineral Resources, which form the ultimate basis of project evaluation, typically consist of tonnage and grade above given cut-off value and also shows the spatial distribution in the deposit. The key aspects of any project evaluation are to assess potential viability and to develop an effective operational design. Optimization of Mineral resources, dilution, ore loss and beneficiation recovery are all modifying factors applied to the resource model during evaluation and determination of viability. However, with constantly depleting mineral resource and ore reserve base in the world and as more metallurgically complex deposits are being developed, mining of large-scale, low-grade deposits becomes imperative. On that note, the selection of appropriate cut-off grade of a bauxite deposit is critical to the success of the project. A careful study of lateritic bauxite orebody shows that there exists a natural cut-off grade, below which bauxite abruptly changes to laterites in the vertical and lateral directions. In a greenfield deposit, the selected cut-off grade should be nearer to this natural change in lithology for optimum resource and grade estimation.

The key objective of any resource evaluation is to develop an effective, value-creating business case for the mining and processing of given asset (the ore body). During the evaluation of deposit, different mining and beneficiation methods are combined and evaluated at different cut-off grades. This process is intended to identify economic combination and ideally the 'best case', which can maximize the value of the asset. Cut-off grade can be considered as one of the most important tool and drivers of project success. It is also important to note that each operation is unique and needs to be considered individually, while selecting cut-off grade and other parameters. Various cut-off grades should be evaluated and compared to select the optimum values based on the net present value (NPV) and life-of-mine. This optimum cut-off not only enhance the resources but also results in ease of mining, processing and minimum waste generation. The characteristic of bauxite deposit is unique and cannot be changed, however, there are always opportunities to optimize mining, beneficiation and metallurgical processes to suit the given asset.

Keywords: Mineral resources, Lateritic bauxite, Cut-off grade, Resource evaluation.

Bauxite Tailings Valorization: From Test Works to Industrial Scale Up

Thomas Baumann[1] and Thibaut Richard[2]
[1]Sales and Business Development, AKW Apparate + Verfahren GmbH
[2]General Manager, AKW Apparate + Verfahren GmbH

Abstract

Over the last years, due to the general decrease in the availability of good quality bauxite raw materials, the need and investigations for new **bauxite valorization** opportunities have gained momentum. This is particularly the case for bauxite tailings, which can in some cases constitute a powerful alternative to mined bauxite.

Since decades, AKW Equipment + Process Design has been exposed to **bauxite washing** and valorization, through the supply of a variety of proprietary equipment up to **turnkey processing plants**, that nowadays constitute a pool of solid and proven references.

To identify potential recovery rates of valuable bauxite and the possibility of improving the overall yield of the process, comprehensive test procedures are the first important step and constitute an important condition for reaching out reliable results and defining performance targets.

Due to the advantage of an own state-of-the-art **technical laboratory**, we performed for a customer an extensive test work package on average bauxite samples, carried out by special trained AKW A+V experts.

Through these capabilities and skills, we could develop a **customized process** allowing the recovery of specific bauxite quality grades, which drove the customer´s decision to erect some processing plants. With the investment of two installations, our customer is now able to treat different types of bauxite material (fresh tailings as well as stock tailings) in the most efficient way and can valorize up to 50% of the tailings as valuable bauxite.

The unique valorization principle and a detailed case study will be presented in the following on the basis of the above selected project.

Keywords: Bauxite valorization, Bauxite washing, Turnkey processing plants, Technical laboratory, and Customized process.

A Fresh Water Free Alumina Refinery

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Abstract

When designing future refineries, more sustainable outcomes that embrace circular economy principles must be incorporated. The reality of a net zero carbon world approaches, demanding net zero carbon refineries. Another key design criterion is the freshwater footprint. Fresh water is a precious resource, essential for life. Climate change will amplify its scarcity in many regions. A refinery that needs no fresh water would be of greater benefit for local communities, reduce environmental impact and environmental risk as well as improving energy efficiency.

In this paper a typical alumina refinery water balance is described, highlighting areas of opportunity. Potential technologies for reducing water footprint are assessed. Incorporating selected technologies into a single process model, a "fresh water free" design is proposed. Designing future refineries for a more sustainable world will require innovative thinking, development of technology and a lot of hard work to deliver robust solutions. These challenges, and a path forward, are discussed within the context of the "fresh water free" refinery.

Keywords: Bayer plant, Water balance and consumption, Seawater cooling, Mechanical vapor recompression (MVR), Alumina sustainability

Improving Yield while Maintaining Product Quality in Bayer Precipitation Circuits

Alex Richmond Aboagye
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Abstract

Alumina refinery operators have to control alumina product quality within prescribed specifications demanded by smelter operators, as well as for environmental and operational reasons. At the same time operators want the highest possible liquor productivity (alumina yield) from their precipitation circuits. Experience shows that precipitation conditions that favor good product quality are often opposed to those that favor high liquor productivity. As a result, alumina refinery operators tend to sacrifice huge production in order to maintain product quality. ARKA

Bauxite and Alumina Consulting Pty Ltd (ABAC) has developed models that can be used to determine the maximum yields achievable in a given precipitation circuit as well as strategies for maintaining product quality within specification.

Keywords: Refinery, Precipitation, Yield, Production, Model, Product and Quality.

Novelty in Commissioning Approach of Utkal Alumina Brownfield Expansion

Abhijeet Bandi[1], Kausikisaran Misra[2], Uttam Giri[3], Vasudev Rao Ghanta[4], Ameet Chaure[5] and Chandan Kishore[6]

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Abstract

Utkal Alumina International Limited (UAIL) has commissioned 0.5 MTPA brownfield expansion hydrate and calcination circuits in Aug '21 and Sep '21, respectively. The brownfield expansion (Project Suryaprabha) is a true reflection of UAIL's growth strategy. Developing confidence on reliability of equipment / system was one of the key focus areas during various phases of the Project vis-à-vis engineering, procurement, material inspection, construction, etc. Basic and detailed engineering was executed with an objective to ensure reliability, safety, operability and maintainability of the expansion facilities, and compliance with statutory and regulatory norms.

Technology equivalence with the existing plant and standardization of equipment considering future expansion were considered during engineering stage itself. Equipment installation was executed, in accordance with a comprehensive commissioning strategy. Several steps were taken to minimize the risk associated with the installation of new equipment such as hazard and operability studies, project management, development of redundancy plans, and trouble-free commissioning of the new equipment. UAIL adopted the structured model of advance and parallel commissioning, where the main emphasis was given to vertical start-up of the new units. The strategy was executed keeping the existing plant operational. During the commissioning, UAIL utilized the spare capacities of existing facilities with special emphasis on risk management, project management, production & engineering. The hallmark of this strategy was, no compromise on safety norms, utilization of the existing plant's volume utilization and unhindered product quality.

UAIL's brownfield expansion ramp-up to nameplate production capacity was achieved in only 6 days, thus creating a new benchmark. This paper presents the methodology used in brownfield commissioning at UAIL thereby facilitating rapid production ramp-up.

Keywords: Alumina Plant expansion, Brownfield expansion, Commissioning, Product Quality, Utkal Alumina, Hindalco.

MAX HT® 550 Sodalite Scale Inhibitor Application at UTKAL Alumina International Ltd. – A "Green Solution" for Alumina Refinery's Sustainable Performance Improvement

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Abstract

During bauxite digestion in the Bayer Process, silica minerals present in the bauxite is dissolved in the caustic liquor resulting in silica supersaturation in Bayer liquor. At temperatures above 85°C, sodium aluminium silicate or Bayer sodalite starts to precipitate as scale on the hot surfaces of process equipment like heat exchangers, transfer lines, etc. This scaling is more significant and problematic particularly wherein high temperatures (>150°C) and high silica supersaturation occur together promoting high scaling rates. MAX HT® 550 Sodalite Scale Inhibitor was developed by Solvay to inhibit sodalite scaling across the evaporator and digester heaters in the Bayer process. This product is being successfully applied at UTKAL Alumina refinery in India since 2016, resulting in significant benefits like debottlenecking the flow restrictions across the digester heaters & evaporators, increased heat transfer, reduced energy consumption and reduced acid waste resulting from reduced heater cleanings. This paper outlines the details of these Green benefits derived out of MAX HT® 550 application at UTKAL Alumina refinery, which are making the refinery operations more sustainable. Based on the plant data, the estimated annual energy savings, when applied to total alumina production, is 651,284 GJ = 48,195 MT of direct Coal savings = 54,075 MT reduction in CO_2 emission equivalent to ~11,755 passenger cars off the road. Moreover, with continuous application of MAX HT® 550, the plant continues to gain benefits like water savings along with reduction in acid handling, improving equipment life, minimizing acidic waste and minimized safety risk of its employees.

Keywords: Sodalite, Scale Inhibitor, Energy Savings, CO_2 emission, Bayer, Digestion, Evaporation.

The Improved Low Temperature Digestion (ILTD) Process for High Silica Bauxites and Aluminous Laterites

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Abstract

The Improved Low Temperature Digestion (ILTD) process is considered to be a breakthrough which enables processing of bauxites and/or aluminous laterites

- in a significantly more viable and sustainable way than the conventional process
- possibly with no waste to dispose of.

It offers numerous benefits compared to the Conventional Low Temperature Digestion Process, including the followings:

- material and energy cost reduction of 15-40% depending on the quality of the feedstock and process conditions,
- savings in the chemical caustic losses by 30-80%, also depending on the quality of the feedstock and process conditions,
- high precipitation liquor productivity of at least 90 g/L,
- higher production rate in the digestion by up to about 25%,
- reduced quantity of bauxite residue generation by up to 30% having an extremely low soda and possibly high iron content,
- recovery of the chemically combined soda and alumina from DSP by-product within the alumina refinery (optional), and
- enables the industrial utilization of bauxite residue.

The ILTD process was originally developed for processing gibbsitic type bauxites, which comprise nearly 90% of the world's bauxite reserves. This paper reviews the status of the development, some options for the utilization of the bauxite residue having low soda and possibly high iron content and that for the desilication by-product (DSP). The ILTD Process is more effective for processing high silica gibbsitic bauxites/aluminous laterites which contain 6% or even more of $R.SiO_2$ (Reactive silica). The breakthrough results (savings in the material and energy costs of about USD 65-85/t of alumina) greatly extend the viable processing of low-quality bauxites and aluminous laterites that have correctly been considered so far to be subeconomic. The worldwide subeconomic bauxite resources and the aluminous laterites that could be used in alumina refineries, where the updated ILTD process would be used, is estimated to be in the range of 20-50 Billion tonnes (Gt). A special emphasis is given to the processing of high silica bauxites and aluminous laterites in India with the ILTD process, having huge resources in the eastern and western parts of the country.

Keywords**: **Production costs, Bauxite residue (red mud), Aluminous laterites, Bayer process, ILTD Process, Waste free process.

CFD Modeling of Cooling Cyclones in a Gas Suspension Calciner for an Alumina Refinery

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Abstract

Cyclones are widely used in various industries for classification of gas-solid or gas-liquid media. Along with the classification of gas-solid media, cyclones are also used as an effective and efficient heat transfer unit. The design of cyclone is very sensitive towards the pressure drop across the cyclones which controls the separation efficiency and the cut diameter. In addition, there are many design combinations which can be used to control performance of the cyclones like underflow diameter, type of feed, cone angle vortex finder length, etc. To optimize all these parameters further, one need to study in quick time using CFD as a tool.

The current study focusses on building a 3-D numerical CFD model based on Navier Stokes equations along with Reynolds stress turbulence model (RSM). A lagrangian method (Discrete phase model) was used to track and capture the alumina particle movement in all the cooling cyclones. This study thus aims to evaluate the flow patterns, temperature profiles and the pressure drop in cooling cyclones. The CFD results were also validated and were found to be in good agreement with the plant data obtained from Utkal Alumina International Limited, Rayagada. Also, CFD simulations were performed for varying sets of incoming air and alumina flowrates, and temperatures. The corresponding impact of the resulting velocity and flow patterns, temperature profiles and pressure drops were critically evaluated. This study on an integrated level of Gas Suspension Calciner would provide understanding and opportunity for process control or change of design from optimization aspects of particle attrition, temperature profile and fuel efficiency.

Keywords: Alumina, Cooling Cyclones, CFD modelling, Flow patterns, Temperature profiles, Pressure drop.

Mixing Behavior Analysis and Its Effect on Precipitation Circuit Productivity

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Abstract

In Bayer alumina process, alumina precipitation circuit consists of growth, agglomeration and coarse/fine seed tanks. All these tanks use an external stirring medium to generate a uniform solid suspension/saturation level which determines the outlet PSD and crystal morphology. The primary job of coarse seed tank is to provide a consistent seed concentration to precipitator tanks. The slurry in the coarse seed tank is continuously stirred with an impeller to avoid the solid settling and to maintain uniform solid concentration inside the tank. Whereas the growth and agglomeration tanks job are to facilitate the conducive environment for crystal growth and agglomeration. In the white side, various technologies are available viz., draft tube, multi-stage, jet loop flow and swirl flow precipitation technology. Despite design variations, all technologies are primarily focused on maintaining uniform concentration in the precipitation circuit.

Kinetic studies of the past literature reveal that there is strong interplay between the hydrodynamic conditions inside the tank and the alumina particle size. However, there studies were limited to batch or lab scale sizes. It is very difficult and computationally expensive to model the industrial precipitation tanks because of the time scale differences of various mechanisms involved in the precipitation process. Hence in this study we explore a new methodology by combining the insights of hydro dynamics obtained from CFD with the empirical correlations to understand the performance of precipitation tank. Additionally, the current study elucidates the vital role of tank slurry levels and internals on flow and mixing in the coarse seed tank.

Keywords: Alumina precipitation, Coarse seed tank, CFD, Mixing Tank, Turbulence, Flow number, Agglomeration.

Advanced Process Control for Grinding Circuit – Unlocking the Potential for Throughput Improvement and Energy Savings in Ball Mills

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Abstract

Volatile market conditions, price fluctuations, variability of bauxite ore, increasing focus on energy savings and efficiency has pushed the alumina industry to achieve higher production with maximum efficiency. Increased market competitiveness, increasing commodity process, volatile coal prices and quality and tighter emission standards mean production and processing method must be modified to reduce energy consumption and lower carbon dioxide output. Data driven technologies – AI/ML, Robust Multivariable Predictive Control Technology (RMPCT), mobile based apps, automation and robotics, the Internet of Things (IOTs), modern data architecture (including the Cloud) can provide solutions to many such problems and open up a plethora of potentials to unlock the true value of any operation/process. Milling operations contribute to a larger extent of energy usage in any alumina refinery and improving the process control strategy in this area can significantly improve the productivity of the asset and efficiency of the process. This paper outlines the development and implementation of an advanced control and optimization technology in Milling circuit in Vedanta Lanjigarh with an understanding of the design considerations and potential of the unit along with the current and future operating constraints of the unit.

Depending on the ore characteristics and targeted plant capacity, the design of the grinding circuit may vary significantly. Typically, the circuit consists of several mills (rod, ball, SAG, AG etc.) in series or in parallel with a number of classifiers and sumps at appropriate locations. Vedanta Lanjigarh uses wet grinding process in its alumina refining scheme with installed 4 nos of Ball Mills. The goal of the grinding section is to reduce ore particle size to a level that enables efficient surface area of the ore (mixed with liquor) to allow efficient desilication and digestion processes. The trade-off between quantity and quality has to be made. It is also crucial to execute this unit operation at the lowest possible energy and grinding media consumption. An optimal grinding process controller must manage a given fresh feed level while keeping the product size within a given range. To accomplish the aforesaid, it is necessary to manipulate the ore feed rate, liquor feed rate and mill speed (if VFD driven). These variables will have a direct impact on mill load, torque, power drawn and slurry density. Adding another dimension of complexity in this process control is the ore size and recirculation load. Often in wet grinding section, there are no proper feedback control loops, but rather, the operator enters feed forward signals such as fresh feed rate to control the recirculation load, thus the resultant actions are determined entirely on the current data and are “reactive” by nature.

To handle such complexities in this section, Vedanta implemented an Advanced Predictive Control to handle multivariable problems with constraints with its digitalization solution provider Honeywell Automation India with multifold objectives of:

- Safe and stable operations with longer life to mill structure liners
- Increased production due to tighter control on process targets
- Reduced consumption of grinding media

Keywords: Robust Multivariable Predictive Control Technology, Advanced Predictive Control, Ball Mills, Feedback control loops, Feed forward signal.

Corrosion Performance of Superhex Heater Tubes Exposed to Alumina Refinery Plant Conditions

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Abstract

Superhex is a high acid corrosion resistance heat exchanger tube that has been exposed to the alumina refinery process condition for the first time in January, 2021. Two brand new heat exchanger units have been tubed with this material and its corrosion performance monitored during the acid wash and Bayer liquor exposure. It's corrosion performance was monitored using a corrosion probe positioned between two live steam heaters (LSH) of an evaporation train and the corrosion rate (mmpy) was measured from electrochemistry data of linear polarization resistance (LPR) and Impedance. Unlike the corrosion assessment in the laboratory, where the parameters surrounding the corrosion cell are controlled and consequently clear electrochemistry data is obtained, the electrochemistry data obtained in the plant is affected by the presence of corrosion inhibitor (low corrosion rates), scale formed during liquor flow (inaccurate corrosion data before the scale is dissolved), and pump mechanical condition (noisy data). It was also observed, that the exposure time of the tube during the acid wash is considerably shorter than during Bayer liquor exposure. Overall, Superhex showed better corrosion performance than other materials under evaluation. One of the units containing the Superhex tubes will be opened for visual inspection around November 2022.

Keywords: Sulphuric acid, Corrosion resistance, ASTM 179, Heat exchanger tube.

Improved Process Control Based on Near Infra-Red Online Analytics

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Abstract

In aluminium production, many steps in the process require an exact knowledge of the material composition to best operate the process or require the input materials to have a certain proportioning for ideal results. Dealing with natural products (bauxite minerals), intermediary or recycled products in the process is challenging as they are not stable. The materials can be analyzed in the lab, but with the time delay the results are only know arrears and this still leaves out the question if the sample taken was even representative.

A logic consequence, also with the increased push towards digitalization, is to move to online analysers which are placed in the field and give a real time analysis of the material composition. It's important to select a technology which is safe, can measure elements/ oxides as well as mineral phases, organics and moisture down to very low concentration levels. Most available technologies can only analyse on an oxide or elemental level. Near Infra-Red (NIR) based online analysis can overcome that limitation and give an online mineral phase analysis whilst simultaneously analysing organics and moisture as well. The NIR technology is already widely used in the Cement and Iron Ore industry. First installations in the alumina refineries and smelters were made as well. Main feature of the technology is that it can provide an accurate analysis of the available alumina and reactive silicate and it does not use any kind of radioactive or gamma-ray sources, which makes the use of the technology extremely safe and no limitations on the operation of the equipment exist.

For the user the direct and online analysis of the different mineral phases of the ore body gives significant advantages – looking back as well as forward in the process: looking back at the mining process, the composition of the currently crushed material can be used for implementing block-models for the mine, which quality of the bauxite is located in the mine. As all raw material is monitored, block-models based on online data are normally much more representative than data from bore hole samples, especially in variable mine sections. Specific tests of mine sections by feeding the crusher with the respective material and monitoring the analyzer results, the reactive Silica content on the stockpile and react accordingly use more variable raw materials for stacking the pile, while not causing problems in the refinery. Looking forward, the composition of the feed to the refinery is now more transparent as the process parameters can be adjusted.

The paper and presentation will showcase the NIR Online Technology and applications. Further impressions and results of the installation in a bauxite mine will be presented.

Keywords: Online Analyzer, NIR, Mineral Phase Analysis, Digitalization.

Mineralogical and Microstructural Analysis of Red Side Process Solids in Alumina Refinery

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Abstract

Alumina Bayer process performance primarily depends on the bauxite quality and stability of the red side process operation. Bayer red side process involves dissolution of siliceous material, i.e., kaolinite in the pre-desilication stage (PDS) followed by the digestion for alumina bearing mineral phase (Gibbsite), solid-liquid separation in a high rate decanter, washer circuit and filter press before the disposal of red mud.

Globally, UAIL is an efficient refinery that operates with lesser amount of soda losses in the red mud, i.e., <4% Na2O/T of red mud by the nature of its bauxite and process. The present work focusses on assessing the soda balance by detailed mineralogical transformation studies of solids processed through the red side of Bayer plant, which uses Eastern Ghats bauxite. In-depth understanding of the process solids and its progressive phases are evaluated to compare with other alumina refineries that involves both higher energy and soda consumption levels with different bauxite composition in terms of silica content. It is observed that a stable desilicated product (Sodalite - $Na8(AlSiO4)6(OH)2.4H2O$ – cubic structure) is formed during digestion process and is most likely found insoluble in the downstream operations viz., decantation and red mud washing stages. The findings of soda consumption levels and solid transformation details have been confirmed through wet chemical, XRF, XRD and SEM analysis.

Keywords: Eastern Ghats bauxite, Bayer process, Sodalite, Alumina, Mineralogy, Energy.

Reducing Iron Impurity in Bayer Liquor

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Abstract

Bauxite generally contains hematite (Fe_2O_3) and goethite ($Fe_2O_3.H_2O$) as major phases of iron, along with minor quantities of siderite (Fe_2CO_3), limonite ($Fe_2O_3.nH_2O$), magnetite (Fe_3O_4), etc. The specific iron minerals contributing towards the iron contamination in Bayer liquor is not

exactly known. However, it is experienced that ferrous iron tends to form colloidal iron hydroxide in Bayer liquor which cannot be filtered through a conventional process and is responsible for iron impurity in hydrate/alumina. It is known that the pregnant liquor, after digestion of bauxite forms sodium aluminate solution in the Bayer process which may contain high levels of colloidal iron and could precipitate with the aluminium hydroxide, produced at the end of precipitation process. This undesirable iron oxide in hydrate / alumina results into a higher iron oxide level in primary metal.

This work is related to a process, developed for the reduction of colloidal iron oxide from the Bayer liquor, leading to the production of high purity alumina in one of our Bayer plants. This route has helped to reduce this impurity in the primary metal. This process finally led to a reduction of 80% iron oxide in the Bayer liquor.

Key Words: Bauxite, Bayer process, Colloidal iron oxide.

Power Saving in Mixing, Steps for a Sustainable Environment

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Abstract

This paper will be presented by STC Engineering, the Technology Partner of REMI Process Plant & Machinery Ltd based at Mumbai engaged in design & Manufacturing of Industrial Agitator.

This Paper draws national attention that with the growth of economy, the demand for energy has grown substantially. Further, the high level of energy intensity in industrial sectors is a matter of concern. In such a scenario efficient use of energy resources and their conservation assume tremendous significance and is essential for curtailment of wasteful consumption and sustainable development. Recognizing the fact that efficient use of energy and its conservation is the least-cost option to meet the increasing energy demand, Being a dedicated supplier, it is our duty to provide institutionalize and strengthen delivery mechanism for energy efficiency services to entity of Alumina Industries. Energy saving is a national cause and all of us will have to join hands and make all out efforts in making India an energy efficient economy and society so that not only we remain competitive within our own market but also are able to compete in the international market.

This paper investigates into how the mixing technology can be improved by using efficient impeller design of Top Entry Agitators for critical Application like Precipitation, Pre-deslication, etc in Alumina process so that process improvement & reduction of power consumption of approx. 25 % can be achieved simultaneously and at the same to fill the gap of challenges between process safety philosophy & the most economical design of Agitator.

This Paper also highlights careful use of resources and consideration of sustainability and opportunity by Saving energy to save operating costs and at the same time to carry out optimization.

The benefits indicated above are demonstrated through efficient design of REMI-STC Agitators supplied for precipitation application. Similar exercise of efficient design of REMI-STC Agitator supplied for pre-deslication process in Alumina Industry to avoid slurry settlement.

Keywords: CFD, Suspension, loads, tip speed, flow pattern, pumping capacities, Power consumption, Density and concentration distribution, allowable values.

Auto Rodder – A Product of the Future

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CEO and Founder of Clearguard Group Pty Ltd.
Inventor – Autorodder.

Abstract

In 2000, Clearguard Pty Ltd developed the **Autorodder** as a result of a fatality in Alumina refining. Primarily, the Autorodder eliminates the need for manual rodding out of plugged **tapping points** and associated risks.

Efficient refinery production relies upon accurate process variable measurement whilst fully plugged instrument tapping points prevent pressure, level, or flow measurement, a partially plugged tapping point creates induced errors. The Autorodder eliminates this problem. Accurate process variable measurement equals efficient process control and generates greater plant production.

Unreliable or lack of confidence in data from robust field instrument created an industry for not only non-contact devices but also reliance on predictive algorithms and software. Over time predictive software, whilst beneficial, is not 100% accurate. The Autorodder allows for real time accurate and precise data from robust, sophisticated, and proven pressure and differential pressure transmitters ensuring that **process variable measurement** is 100% accurate.

Additional tangible benefits from the Autorodder include massive savings of parasitic purge resulting in additional savings to the use of caustic soda in the alumina refining process.

It has a become standard practice with Alcoa, South 32 and Rio Tinto Alcan (QAL) to specify and use Autorodders for all pressure and contact type level measurements in slurry and scaling applications. Autorodders are in use at Ma Áden, EGA, Noranda and Almatis Alumina Refineries.

Autorodders have also improved environmental outcomes in Coal Fired Power Stations at South Georgia Power – USA, Prairie State Energy Campus – USA, Malakoff – Malaysia and Rio Tinto Yarwun – Australia. These outcomes have been achieved by enabling “real time” process variable measurement ensuring optimal performance by Scrubbers and Filters used to clean environmentally damaging toxic emissions.

Replaces high risk manual rodding out	Proven to make plants more efficient	Enable precise, real time data measurement	=	Product of the future

Keywords: Autorodder, Tapping points, and Process variable measurement.

Early Phase Separation and Disc Structure: Two Keys to the Reliable Operation of the First 7.5 m Diameter Vacuum Disc Filters

Adrien Dagallier
Gaudfrin

Abstract

With 200 **vacuum disc filters** sold in the last 25 years to alumina refineries, Gaudfrin not only became one of the leading manufacturers for the industry, but also gained an unrivalled experience through the operating feedback of the 26 refineries where these filters have been installed. This allowed, along the years, continuous testing and validation of new technical features that were designed specifically for alumina trihydrate filtration. These developments initially focused on the mechanical lifetime of the **discs**, subjected to heavy loads and high rotation speeds, by abandoning in the 90's the already outdated tie-rod design. Focus then progressively shifted towards the reduction of residual **moisture** with the design of a unique system of cake formation zone isolation valves that provided flexibility for the operators to optimize **drying** ratio when faced to variable process conditions while ensuring a maximized cake formation **vacuum**. It soon became clear that the next challenge would be increasing the size of the **filters** to follow the increasing capacity of alumina refineries productions lines. Diameter of the discs had progressively been stepped up from 3 to 6m, at which point it reached a glass ceiling mainly because of **hydraulic** limitations and too short mechanical lifetime of the large **disc** components. This glass ceiling could not be breached until 2016 after all the related technologies had matured enough with two technical improvements that were keys for Gaudfrin to finally produce the first 7.5m disc diameter units: an early phase separation of filtered liquor and air through a re-designed **hydraulic path**, and a **disc** structured of narrow and thin metal framed sectors fabricated with a new process that extended their lifetime by several years. The early phase separation together with the small internal volume of the **discs** made it possible to drain liquor out fast enough to operate a **filter** with 7.5m diameter **discs** up to 5 rpm without compromising on productivity and residual **moisture**.

Key words: Vacuum, Disc, Filter, Moisture, Drying, Hydraulic.

Relevance of Tube Digestion Technology in High Temperature Alumina Refinery

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Abstract

Selecting a proper technology for digestion unit is always given a special consideration where nature of ore requires digestion circuit to be operated at high temperature in the range of 250° to 280°C. The evolution of tubular digestion over last few decades has played a key role in helping refineries to achieve their goals. This technology provides optimal energy efficiency for the high temperature refineries by reducing the operating and capital costs of the digestion unit and the entire refinery. The tube digestion flowsheet combines the bauxite and caustic liquor streams together in a single stream prior to regenerative heating and final temperature is achieved via indirect heating with steam, thus, considerably reducing the plant evaporative requirements. Flash trains are designed such that heat liberated matches heat sink to improve energy efficiency. With the benefits of maximizing extraction, energy efficiency, process simplicity, ease of operation, cleaning & maintenance and plant utilization, tube digestion technology has been selected increasingly the technology for refineries around the world. This paper provides a brief overview of the technology.

Keywords: Tubular digestion technology, High temperature, Energy efficiency.

Metso Outotec's 5th Generation of CFB Alumina Calciners – Optimized Process and Equipment Design

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Abstract

Metso Outotec and its predecessor companies introduced the CFB calcination technology to the alumina industry in 1970, and since then it has gone through several development stages with more than 60 installations worldwide, resulting in the latest generation of state-of-the-art CFB calcination technology that Metso Outotec has provided to recently commissioned alumina refineries.

The continuous design evolution of our CFB technology finally culminated with the development of the Generation 5 Calciner. The clear intent has been to advance the integration of the calciner flowsheet and to reduce overall plant weight. For example, by the implementation of a highly efficient pre-separation stage prior to the electrostatic precipitator has significantly reduced the

required size of the ESP without compromising the low dust emission figures. Furthermore, the air-lift system can be replaced, and only a lean pneumatic transport system for the ESP dust is required. At the same time, latest key equipment design developments have been implemented to improve the plant performance. These design improvements include the optimization of critical process equipment, all contributing to both an energy efficient as well as reliably stable plant operation.

Metso Outotec's Generation 5 alumina calcination technology has been successfully applied at 3 alumina refineries for a total of 5 units with a maximum capacity of 3500 tpd of alumina production.

Keywords: Alumina Calcination, Circulating Fluidized Bed, Specific Energy Consumption, Capital cost.

Solid-Liquid Filtration in Alumina Production – Developments to Date and Future Outlook

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Abstract

The transformation of bauxite into alumina is a quite complex process. The kind and quality of bauxite plays an important role regarding the process conditions. But the deposit and how it is treated and shipped/transported to the refinery have influence on the extent of solid-liquid filtration steps. The paper will show the developments made to date with regard to the filtration equipment used for the solids-liquid filtration steps in the alumina process which are:

- Bauxite filtration (prior to digestion),
- Bauxite residue filtration,
- Green liquor filtration (polishing filtration),
- Fine seed filtration,
- Ca-oxalate filtration,
- Coarse seed filtration, and
- Product filtration

As a consequence of these developments to date, the paper concludes and shows the most appropriate filter equipment for the various filtration steps listed above.

In a second step the paper will list and discuss current issues and future targets of the refinery operators. This will cover questions like quality improvement, energy saving and cost reduction in general. But it will touch as well the challenges coming with reduction of CO_2 emission, ideally down to zero.

In a final outlook adapted and new plant concepts such as digester blow off (instant filtration of slurry exiting digestion) will be discussed as far as solid-liquid filtration may play a role in it.

Keywords: Bauxite, Solid-liquid filtration, Appropriate filter equipment, Current issues, Future targets, Digester blow off.

A Way to Use Local Bauxite Resources and to be Independent

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Amber Development SAS, France

Abstract

For several years now, some of the world's alumina-producing regions have been faced with a shortage of good quality local bauxite to meet the growing demand of the aluminium market. It makes production more complex and costly. A widely used solution is to import bauxite.

This solution is not always possible or economical.

Moreover, there is a growing demand to use resources close to the refineries for strategic, economic and ecological reasons.

The IB2 process is a solution applicable to some bauxites. The principle is to separate the silica from the kaolinite before the bauxite is fed into the Bayer process.

This is achieved in 2 key steps: Roasting of the bauxite

Leaching of the calcined bauxite

The beneficiated bauxite is then digested at low soda concentration with a low evaporation cycle.

During the bauxite roasting, the main transformations are shown below:

Phase	Formula	Dehydroxylation		Transformation		
Gibbsite	$Al(OH)_3$	280°C	540°C	κ-Al_2O_3		α-Al_2O_3
				750°C		1020°C
Boehmite	γ-AlOOH	500°C	600°C	δ-Al_2O_3	θ-Al_2O_3	α-Al_2O_3
				850°C	930°C	1050°C
Diaspore	α-AlOOH	450°C	600°C			600°C
Kaolinite	$Al_2Si_2O_5(OH)_4$	$Al_2O_3,2SiO_2+H_2O$		γ-Al_2O_3+Mullite+SiO_2 amorphous		
		530°C	590°C	900°C	1000°C	
Muscovite	$KAl_3Si_3O_{10}(OH)_{1,8}F_{0,2}$	$KAlSi_3O_8+Al_2O_3+H_2O$		α-Al_2O_3+Mullite+SiO_2 (cristobalite)		
		820°C	920°C	1100°C	1200°C	
				Polymorphic Transition		
Quartz	SiO_2			α	β	
				573°C	870°C	
Goethite	α-FeOOH	290°C	330°C	α Fe_2O_3		
				330°C		
				Thermal Dissociation		
Calcite	$CaCO_3$			895°C		

With the IB2 process silica is removed in the form of hydrated calcium silicate which is a material that has several applications. Silicate has a high CO_2 capture capacity and these applications can be satisfied with or without CO_2 capture.

IB2 consists of two steps: a significant improvement in the quality of the bauxite and an improvement in the performance of the Bayer Process due to the reduction of silica and impurities. This makes it possible to process very poor-quality bauxite located close to refineries and to avoid importing and transporting it over long distances.

An example of bauxite improvement:

		Raw	IB2
LOI	%	13.7	2.2
Al2O3	%	51.6	71.5
SiO2	%	19.3	7.1
Fe2O3	%	8.2	11.6
A/S		2.7	10.1
A-S		32.3	64.4

The IB2 unit is plugged on the existing refinery and is flexible.

Keywords: Shortage of good quality bauxite, IB2 process, Bauxite improvement.

Precipitation Process Intensification Using Mixed Seed in Bayer Circuit

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Abstract

In the present scenario, in Bayer's process, precipitation from sodium aluminate liquor is being carried out using gibbsite seed. Caustic soda solution is enriched with maximum alumina dissolution in the digestion step and subsequently, alumina is precipitated from the solution. Aluminium hydroxide as seed provides surface area for the deposition of alumina from the supersaturated liquor. Increasing the seed surface area may accelerate the precipitation process and might improve liquor productivity. Hence, enhancing precipitation yield by using mixed seed, i.e., using active aluminium hydroxide seed along with conventional gibbsite seed can be one of the methods of precipitation process intensification. The paper is an exploratory work wherein the kinetics of the precipitation study carried out by gibbsite, active and mixed seed have been investigated. A comparative study has been made between these with the possibility of using mixed seed in precipitation. Properties of active seed have been compared to that of conventional gibbsite seed. The precipitation process with gibbsite seed and with mixed seed have been explained using schematic diagrams. The study shows that using mixed seed enhances liquor productivity which will reduce the operating cost per ton of alumina production with several other advantages and maybe a plant implementable process.

Keywords: Precipitation, Kinetics, Conventional seed, Active seed, Mixed seed, Liquor productivity.

Carbon Footprint Reduction in Alumina Calciners

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Abstract

As the creators of the most advanced alumina calciner systems in the industry, we value staying at the forefront of research and development. Our engineers analysed every aspect of our Gas Suspension Calciner (GCS) system and discovered opportunities to address energy efficiency, and economy of scale.

Building on a world-class design, we made numerous enhancements to improve performance while reducing costs. Our recent developments are a direct result of our customers' desire to maximize throughput, cost efficiency, and alumina quality.
The following improvements bring our customers better control and consistent results without a premium price. The result is improved cyclone design, better refractory, smarter digital interface, and lower building height.

And in keeping with our Mission Zero goals, our latest technologies and digital solutions help customers move towards greener processes by reducing thermal energy and power consumption as well as CO_2 emissions.

After research and development of hydrogen firing in alumina calciners, we are now into real time projects to meet our goals of Mission Zero.

Keywords: Alumina, Calciners, Thermal energy consumption.

NON-METALLURGICAL BAUXITE-ALUMINA

A Review of High Purity Alumina Industry

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Abstract

High purity alumina's (HPA) of 99.99% purity or better find applications in the critical areas such as LEDs, Li-ion batteries, etc. A number of companies are engaged in research, development and pilot and commercial scale of production of HPAs. Different processes are available. Efforts are in progress to find suitable cheaper raw materials and economically viable process routes. Demand for HPAs is projected to be very high in the next few years. This paper is a summary review of publicly available literature covering properties, applications, processes and supply-demand for HPAs.

Keywords: High purity alumina, Summary review.

Non-Chinese High-Grade Bauxite Available for India for Many Applications

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Abstract

The Bonasika bauxite deposit in Guyana has some of the best refractory grade bauxite in the world. The unique properties, when sintered, of a high corundum with a minor mullite phase combined with low impurities have shown this source to be an excellent high alumina refractory. The new Guyanese deposit fills a gap in the alumina portfolio as a unique product at 93% alumina with extremely low impurities, low silica, low alkalis with lower porosity and high refractoriness. Certain production methods and variations lend researchers to see a substitute for brown-fused and tabular alumina in many applications. The raw ore is a substitute for ATH in flame retardant applications as well as an excellent feed aluminum sulphate production. When calcined, it is a feed for BFA production with faster production times due to less refining.

This paper will review the properties, markets, and status of the new Guyanese bauxite deposit, now available to the Indian market through a domestic calciner, along with the history of the development of this source.

Keywords: Bonasika bauxite deposit, Unique properties, High alumina refractory.

Bauxite for Production of Abrasive and Refractory Grade Calcined Bauxite

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Abstract

Dharti Industries Private Limited (DIPL) is a renowned company engaged in calcining of raw bauxite over 12 years. Dharti Refractory Minerals Pvt. Ltd. (DRMPL) is our recent acquisition of Dharti group for the manufacturing of refractory grade calcined bauxite. Our both calcination plants (DIPL & DRMPL) use Rotary Kiln technology for production of calcined bauxite. We source raw material from Kolhapur and Ratnagiri, Maharashtra; Belgaum, Karnataka; East Godhavari, Kakinada, Andhra Pradesh; Chhattisgarh, Madhya Pradesh and we are also in long-term supply contract for Bonasika Washed Bauxite (BWB) with First Bauxite LLC (FBX), Guyana, S.A. Indian refractory industries is importing >95% of its total consumption of refractory grade calcined bauxite from China. However, this is now facing problems such as consistency of quality of the products, timely delivery and the Indo-China political frictions. Keeping this view, Dharti group have signed a long-term supply contract with FBX for Bonasika Washed Bauxite (BWB). FBX produces the world's best quality non-metallurgical grade washed bauxite and DIPL have conducted successful trial runs using this bauxite and achieved Bulk density >3.25gm/cc and apparent porosity <7% with grade ranges from 82-90% Al_2O_3. These chemical and physical properties of calcined bauxite are considered suitable for use in Indian refractory industries.

Keywords: Calcined Bauxite, Refractory, Abrasives, Non-metallurgical Bauxite, BWB, Bulk Density and Apparent Porosity.

Non-metallurgical Grade Bauxite - Status and Future Prospects

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Abstract

At present, about 85% of the bauxite is utilised for the production of alumina. The resources of high-grade bauxite suitable for non-metallurgical applications (refractive, abrasive) are very limited. The high-grade ores are occurring in pockety deposits in the states of Gujarat, Maharashtra, Chhattisgarh and Jharkhand. The specification for the utility of bauxite in non-metallurgy applications (refractory, abrasive, chemical, cement) is very stringent with reference to iron oxide and alumina (Al_2O_3) percentage. The bauxite should contain low iron oxide (Fe_2O_3-<5%) and high alumina (Al_2O_3->55%). Due to this, India is importing specific qualities of bauxite to fulfil the requirement of the industry. According to the global export-import data, India's

estimated imports of bauxite climbed 27.13% from 2018 and export during 2019-2020 is only 0.7 million tonnes, shows an upward pattern for bauxite import.

JNARDDC has evaluated the lateritic bauxite deposits of India and categorized them from an industrial perspective. In this paper, an attempt is being made to highlight the current status of non-metallurgical bauxite resources and market scenario in India. The trials on the conversion of high alumina bauxite from ferruginous bauxite have been done at JNARDDC. The emphasis is given on the possibility of conversion of low-grade bauxite into calcined bauxite.

Keywords: Bauxite, non-metallurgy, Product, Calcined bauxite.

Refractory Raw Materials, Indian Scenario, Challenges and Possible Solutions

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Abstract

Refractories are the materials which are used in furnace lining for high temperature application in steel, cement industries, power plant and petrochemical industries. Refractory industry is also called the Industry behind Industry. In refractory industry, raw bauxite is used in the production of high alumina cement. The calcined bauxite, calcined alumina is the main raw material used for manufacture of high alumina castables, such as low cement, ultra-low cement castables and conventional castables and bricks.

Refractory industry is presently passing through a difficult time because of variety of factors such as raw material availability issues, increase in prices of raw materials and continuous pressure from customer for higher quality and cheaper price. Non-availability of refractory grade raw material in India is one of the major challenges for the refractory industries. Over the years, Indian refractory industries were dependent on Chinese for supply of various raw materials, now however, the recent changes in Chinese government policies regarding export of raw materials and steep rise in prices have almost stopped import of good quality raw material.

India's refractory industry sources almost half of its raw material from China and is now bracing for shortage that could adversely impact the steel, alumina, cement and glass industry.

Refractory industry is operating on thin margin and high working capital. Recently there is 30-40% rise in the prices of raw material and hence selling price of refractory has gone up by almost 40%. On the other hand, there is continuous pressure from end user customers for price reduction because of which refractory industry is almost at the verge of subside.

This paper explains the challenges, being faced by refractory industry due to non-availability of good quality raw materials and proposed some long-term solutions.

Key words: Raw Bauxite, Refractory, Calcined Bauxite, Castables, Challenges, PCPF Shapes.

Alumina Based Ceramics – Problems and Prospects

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Abstract

Alumina based ceramic products are widely used in a variety of applications such as Wear and Corrosion Protection, Engineered Products and Vacuum Electronics. This is made possible because alumina can be formulated with additives to tailor the properties and meet the varied application requirements. The relationship between the formulation, properties and applications is key for the successful development of these products.

While this is an exciting prospect, the availability of calcined alumina, a key raw material, is becoming increasingly scarce and expensive. Dedicated plants for producing calcined alumina are the need of the hour to meet the increasing demand for these raw materials. Added to this, the increasing energy costs are pushing up the cost of manufacturing the sintered products.

There is a need for strategic capacity creation for both alumina raw material production and manufacturing plants with a global scale capacity for manufacturing sintered and finished alumina-based products.

Keywords: Alumina, Ceramics, Calcined alumina, Sintered products.

Synthesis of 3N Pure Alpha Nano-Alumina from Aluminium Foil

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Abstract

High purity alumina (HPA) is a processed premium non-metallurgical alumina product characterized by its purity level, i.e., 99.9% (3N), 99.99% (4N) and so on. Recently world demand for high purity alumina has gained an incredible traction, owing to growing technological advancements and increasing demand from applications namely LED bulbs, electronic displays, automotive and medical.

The present work focuses on preparing □-phase of 3N pure nano-alumina from aluminium foil using alkoxide process. High purity aluminum alkoxide is synthesized from aluminum foil and

alcohol, and hydrated alumina is produced by hydrolysis of alkoxide, and finally high purity alumina is obtained by calcination. XRD studies showed that α-alumina was obtained by calcining hydrated alumina at high temperature of 1200^{o}C after the re-arrangements of oxygen packing. Ideally α-phase of alumina was obtained after calcination of hydrated alumina via different intermediate phases (γ,δ,θ etc). Complete phase transition to thermodynamically stable phase of alumina (□-phase) strictly depends on the control of hydrolysis conditions as well as uniformity of temperature distribution during calcination. Micrographs of 3N powder showed nano size particles resulted in higher surface area and this kind of mesoporous structure could be suitable for various applications, i.e., adsorption and catalysis. The cost benefit analysis for the preparation of alumina by both routes revealed that alkoxide method proves to be an economical route to get highly pure alumina with controlled conditions of hydrolysis, drying and calcination.

Keywords: Alumina, Hydrolysis, XRD, SEM, TGA.

BAUXITE RESIDUE (RED MUD)

Bauxite Residue Utilisation in Cement: The European Perspective

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Abstract

Responsible for approx. 6-7% of total greenhouse gas emission, the cement industry is obliged to reduce its environmental footprint. Finding sustainable solutions to reduce carbon emissions will enable the industry to maintain its license to operate for future decades.

This is particularly true and binding in Europe, where the **European Community** and its 27 Member States positioned themselves at the forefront of directives, laws and development strategies to target and achieve **carbon neutrality** by 2050.

This demanding goal has been embraced by Cembureau, the European Cement Association, in setting their roadmap and defining actions in the so-called 5C's: clinker, cement, concrete, construction, (re)carbonation.

After an overview of the legislative and industrial environment, this paper will focus particularly on the situation related to present and future challenges in the field of **supplementary cementitious materials** (SCM), i.e., raw material availability, quality, and expected changes thereof. All of which is underpinned by the fact that reducing clinker content of cement is the first action to reduce CO_2 emissions from the cement production.

Of all the cement constituents Clinker is the most energy consuming and CO_2 emitting making composite/blended cements incorporating SCM a viable replacement of Ordinary Portland Cement (OPC) on the market.

In view of expected shortage and decreased quality of conventional SCM in middle term span, innovative SCM based on processed **Bauxite Residue** (BR) can help the cement industry worldwide to fulfil its commitment towards sustainable production, reduced environmental impact and **circular resource management**.

Nonetheless, cross-industrial commitment, support from the legislators and new approach to standardization are required to make this possible.

Keywords: ***European Community, Carbon neutrality, Supplementary cementitious materials (SCM), Bauxite Residue (BR), Circular resource management.***

Tailings Management and Sustainability

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Abstract

Tailings are typically generated by the downstream processing of the mined ore, aiming to separate the valuable minerals from the uneconomic fraction of the run-of-mine (ROM). The long-term sustainability of a mining operation is intrinsically linked to the management of tailings: stakeholders expect that the need to raise the height of permanent tailings storage facilities (TSFs), or to build new ones, should be minimized or avoided altogether.

This paper presents a novel technology of tailings management developed at Hydro's Paragominas bauxite mine, in 2019. This innovative solution, the tailings dry backfill (TDB) technology, affirms Hydro's position of technological leadership in the mining & metals industry, successfully solving the challenge of managing the tailings generated by its bauxite mine. The main benefit obtained from the full-scale implementation of TDB at Paragominas is the elimination of the need to build new TSFs, or to raise the walls of existing ones. In the case of Paragominas, the TDB allows a reduction of 850 hectares in its environmental footprint.

Keywords: Bauxite tailings, Tailings management, Mining.

Microwave Processing of Red Mud for Recovery of Metallic Values

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Abstract

Red mud is an inevitable and under-utilized byproduct of the aluminum industry. Red mud can be deemed as a polymetallic source comprising alumina, silica, titania, and iron. Alkaline nature (high pH) with considerable alumina and silica impurities leads to higher flux consumption, furnace wall erosion, and slag generation, making it unsuitable for conventional smelting reduction. The non-contact heating source with volumetric and in-situ heat generation in the sample mass by microwave exposure leads to an efficient reduction of iron oxide in red mud. The dielectric properties depict a positive response towards microwave processing. The interlocked structure of red mud is distorted by the selective heating of iron-bearing phases. The investigated carbothermal processing route yielded iron enriched magnetic concentrate with Fe grade of 54% and 95% Fe recovery composed of majorly magnetite and hematite phases. The prolonged

exposure resulted in ferrite formation in 30 min suitable for DRI making. The non-magnetic concentrate is subjected to acid leaching, followed by precipitation for refractory applications. Microwave reduction of red mud offers better iron purity concentrate with lower carbon consumption and reduced processing time, thereby mitigating green-house gaseous emissions. The proposed processing route resulted in bulk utilization of the red mud by generating sinter grade feedstock for DRI production and refractory grade mullite rich products. Different processing routes will be discussed in this study.

Keywords: Microwave, Red mud, Iron, Mullite, Leaching, Ferrite.

Process for Soda and Alumina Recovery from Central Indian Bauxite Residue

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Abstract

Alumina is being extracted using Bayer's process. However, the major concern of all global alumina refineries is disposal and management of landfill sites of hazardous red mud or bauxite residue. Due to high alkalinity (pH~13) and leachable soda content, bauxite residue poses challenges with respect to the handling, storage and utilization. Also, the presence of high alumina in bauxite residue restricts the use of high temperature processes for the extraction of iron values and requires higher flux for slagging. Therefore, minimization of the alumina and alkali content in bauxite residue not only solves the issues of waste management or utilization but also greatly enhances the economic feasibility of process by increasing the alumina recovery with lower specific caustic consumption in Bayer process.

Many researcher groups reported high temperature roasting of bauxite residue using solid sodium hydroxide, which increases the formation of leachable sodium aluminates. In our research work simultaneously, lime was also added to form stable silicates. Dosages of soda, lime (CaO) and roasting temperature were optimized along with residence time with an objective of maximizing the recoveries of soda and alumina. Thus, low alumina bauxite residue produced in this process can be easily processed for the iron recovery. This offers the sustainable solutions for complete utilization of bauxite residue. The lab scale optimization results of roasting followed by leaching demonstrated up to 70% alumina and 50% soda recoveries. The results of this work are discussed in this paper.

Keywords: Bayer Process, Bauxite residue, Roasting, Alumina recovery, Soda recovery.

Extraction of TiO_2 from Titaniferous Bauxite Residue

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Abstract

The Bauxite Residue (BR) produced by Bayer's Process poses great disposal as well as environmental issues. However, some of the Indian Bauxite Residues (BR is equivalent to Red Mud which was used in some previous literature), especially the BRs produced at Renukoot and Muri Refinery of HINDALCO, have a great commercial potential as it contains 17 to 19% TiO2 (highest % of TiO2 found in BR produced anywhere in the world). In this process such titanium rich BR is first subjected to HCl leaching due to which the oxides of aluminium, iron, sodium, calcium, etc. present in the Red Mud get converted in to their respective soluble chlorides while titanium oxide (TiO_2), silica (SiO_2) & REOs (Rare Earth Oxides) being insoluble in HCl get precipitated. Titanium oxide (TiO_2), silica (SiO_2) and REOs are separated from the Mother Liquor by filtration and taken for TiO2 recovery either as rutile by chlorination or in the form of ferro-titanum by alumino-thermic reduction. The mother liquor containing mainly $AlCl_3$ & $FeCl_3$ is taken to Acid Regeneration Plant (ARP) where the chlorides get converted to their respective oxides i.e., Al_2O_3 & Fe_2O_3 and HCl is recovered back which is used again for leaching. This mixture of Al_2O_3 & Fe_2O_3 is then subjected to caustic leaching to convert Al2O3 in to water soluble sodium aluminate which is then converted to aluminum hydroxide (Al $(OH)_3$) by hydrolysis and finally to pure alumina (Al_2O_3) by calcination. As TiO_2 & SiO_2 etc. have already been removed, the iron oxide left behind is fairly pure (Fe2O3 – 93 to 94%) & hence can be sent directly for pelletization. Thus, this process ensures complete utilization of BR, instead of dumping it as a waste. As there is no need to subject the BR to briquetting or reduction roasting which requires the use of carbon (as has been suggested in some processes), this process greatly reduces carbon emissions. As the reality of a net zero carbon world approaches, this process is a step in that direction.

Keywords: Titaniferous-BR, Acid Leaching, Acid Regeneration Plant.

A Sustainable and Profitable Bauxite Residue Valorization Process

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Abstract

Around the world, the extraction of alumina from bauxite annually generates about 175 million tonnes of **bauxite residues (BR)** containing scandium (Sc), **rare-earth elements (REE)** and other valuable metals, that are otherwise currently accumulating in storage ponds. With lack of storage space, environmental regulations becoming more stringent and the surge in REE demand, the need for a **sustainable** approach to extract value from these residues, while minimizing waste

volume, is imminent. The avenue of BR **valorization** has been explored for decades but to this day no approach has been successful at the commercial scale. Different processes were proposed but they are either not economically viable, or do not reduce waste volume sufficiently to serve the alumina producers' needs to increase the lifespan of the plant. Moreover, environmental impacts may be displaced towards effluents or another waste material that is even harder to manage.

A successful valorization approach should reduce waste volume effectively and economically by recovering the value of both bulk (Fe, Al) and critical (Sc/REE) metals. The "complete" or "**zero-waste**" approach to the valorization of BR is proposed in the literature to recover as many components as possible to minimize waste volume and get the most value out of the feed. The main proposed processes are based on direct acid leaching and/or iron smelting, each posing technical and economical limitations. Direct leaching with mineral acids creates large volumes of effluents and is expensive owing to low selectivity and thus extensive separation steps. Iron smelting is energy-intensive and presents technical challenges in the furnace related to sodium and aluminium content in BR. Moreover, proposed processes have their economy based on the market price of multiple pure metal oxides which complexifies further the process to meet market specifications and burdens the project with higher capital risks.

INNORD proposes an innovative process that targets the recovery of various metals in the form of concentrates as first marketable products to reduce the CAPEX, simplify the process, and minimize waste volume. The recovery of bulk metals (Fe, Al) in addition to valuable metal concentrates (Sc/REE, Ti) maximizes volume reduction (+70%) and improves revenues. The process consists of multiple selective steps to facilitate separation of each metal: alkalinity (Na, Ca) and desilication product (DSP) removal, iron conversion followed by leaching and iron separation, Sc/REE recovery, and aluminium recovery. In addition to Fe, Al, Ti, and Sc/REE concentrates, the alkaline elements and silicates are converted into sellable by-products, thus further reducing waste, and avoiding neutralization effluents. One advantageous feature of the process is the closed-loop **recycling** of major reagents to minimize effluents and further reduce the operating cost of the BR valorization plant.

Keywords: Bauxite residues (BR), Rare-earth elements (REE), Sustainable approach, Valorization, Zero-waste, Closed-loop recycling.

Recovery of Mineral from Red Mud and Disposal Solution to Provide Green Footprint to Alumina Industry

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Abstract

Red mud contains minerals as residue which can be recovered using advanced technology and can be used for further processes to provide a sustainable circular economy within alumina refinery operation.

We need disruptive changes and innovation in the process to handle 1 to 2.5 tons of red mud waste generated per tonne of Al_2O_3 production. FLSmidth is engaged in continuous R&D to innovate processes and equipment to support the Alumina industry to reduce carbon footprint while discharge of tailing.

We also need to relook at the dewatering process to solidify the red mud slurry into a high solid filter cake that can be safely stacked in dry storage areas with a green footprint.

FLSmidth is engaged in conducting filtration test work with both vacuum and pressure filtration technology to design the best configuration which can be economically suitable to handle various factors affecting the filtration rate and final cake concentration.

This paper details the advanced technology options for recovering minerals and various flow sheet options backed by test work for efficient red mud filtration and disposal solutions which will provide a green footprint to the alumina industry.

Keywords: Mineral recovery, Red mud filtration, Flow sheet, Filter press, Dry tailing, Dry stacking.

ALUMINIUM SMELTER

Make Your Anode Baking Furnace Smart and Greener

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Abstract

As a major emitter of **CO_2**, the Aluminum industry takes initiatives to decrease its environmental footprint. Inside the smelter, the focus is on electrolysis as main contributor followed by the anode production. As part of this global effort, transformations in the **anode baking furnace** are in progress to limit its own emissions while maintaining good and consistent baked anode quality for the electrolysis process.

One of the major changes in progress is the fuel switching as most of the furnaces using Heavy Fuel Oil are now converting to Natural Gas and studies have started to use hydrogen. While these changes help reducing emissions like SO_2 and CO_2, there are others to take into consideration such as NOx and PAH.

Though an extensive R&D program and a long experience with the different furnace suppliers, FIVES Group proposes new solutions for greenfield and upgrades of anode baking furnaces to reduce their emissions and improve their performances.

FIVES **Firing Control Systems** (FCS) are equipped with patented **low NOx gas injectors** to reduce at the source, the NOx emission while providing better baking homogeneity. They also include central computers with embedded advanced control functions to achieve consistent anode quality while reducing fuel consumption and PAH emission. The Firing Control System (FCS) is now connected with FIVES Fume Treatment Center (FTC) in order to develop new control synergies to improve furnace safety and emission capture.

Amelios Suite, the FIVES carbon digital solution, closing the loop between carbon and smelting data, includes several modules dedicated to anode baking furnace:

- The baking data analysis module provides Key Performance Indicators (KPI) to follow and optimize the baking process.
- The Flue Wall Monitoring module computes field observations along with the baking data for refractory follow-up and maintenance planning.

Based on web technology, these KPI are available for all actors of the anode baking performances: in the control room, in the offices for the supervisors and process engineers and directly on the furnace through connected devices.

Eventually, thanks to these digital tools and through service contract, FIVES experts can remotely connect and assist customers to troubleshoot or optimize the anode baking process. State of the art equipment combined with **4.0 technology** make the anode baking furnace smart and greener.

Keywords: Emissions, Heavy fuel oil, Natural gas, Firing control systems, 4.0 technology, KPI.

The Digital Smelter: How to Enable AI and Digital Twins

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Abstract

Aluminum companies contend with an unpredictable market and volatile commodities pricing. In response, these companies must increase tonnage while reducing cost, and they are often pressed with making important decisions in uncertain circumstances. They seek out AI-driven technologies and Digital Twins in pursuit of more stable results in their operations to increase tonnage throughput, improve quality and even achieve autonomous operations. But first, they must lay down the proper data foundation to take advantage of the many benefits that AI and Digital Twins can offer.

Increasing output while reducing production costs is every company's dream. However, achieving that dream requires optimized assets, processes, and optimizing strategies without compromising team member safety and their increasing sustainability challenges. Now, many companies are looking for new ways to improve efficiency and overall production by embarking on a digital transformation journey. Digital transformation enables key stakeholders to turn operational data into quantifiable business results. Unfortunately, many companies are struggling getting value out of such initiatives. They are not taking a structured approach on new deployments, focusing on implementing new artificial intelligence (AI) or Digital Twins technologies without first having the right operational data foundation in place and making sure their people are properly empowered.

This paper will provide the following:

- A simple definition of AI and the benefits of adopting it into your operations,
- An AI maturity model,
- The anatomy of a successful AI project,
- An operational view of a Digital Twin, and
- Real-world examples and success stories.

Keywords: Unpredictable market, Digital transformation, Quantifiable business results, AI-driven technologies, Digital Twins.

Discussions on the Importance of Retrofit Projects in the Years to Come and Review of a SAMI Retrofit Project in QTX Smelter in China

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Abstract

So far in the 21st century, the aluminium industry smelting capacity expanded mostly in China through greenfield projects involving the usage of recently developed high amperage cell technologies. The most recent being the NEUI400, NEUI500, NEI600, GP420, GP500, GP530, SY400, SY500 and SY600.

This period of rapid greenfield expansion has recently halted. Most realistically, in the near future, smelting capacity expansion will come mostly from brownfield retrofit projects also named capacity creep projects. There is huge potential for such projects in China, in particular, as the above mention cell technologies have been developed extremely quickly leaving no time for technology optimization.

Outside of China, some aluminium producers have developed extensive expertise in carrying on successful cell retrofit projects. We can quote, for example, the AP24 retrofit of the AP18 and the AP40 retrofit of the AP30 from Rio Tinto, the D18+ retrofit of the P69 (through the D18) and the D20+ retrofit of the CD200 (through the D20) from EGA. Some other retrofits are not so well advertised like the Alcoa retrofit of the AP30 into a cell running around 400 kA per example or the PA-LE retrofit of the AP24 from Pacific Aluminium. Let's review first the past major retrofit stories just quoted.

Inside China, the installed capacity is very recent and hence modern, but the technology used is not quite optimized in term productivity when compared to the technology developed outside of China through extensive use of the cell development cycle. SAMI did retrofit the QTX smelter in China, that retrofit will be reviewed next.

Finally, the author recently published a demonstration retrofit study aiming at demonstrating the creep capacity in China. This demonstrates the huge potential of future retrofits of Chinese cell technologies used in China and India.

Keywords: Cell retrofit, Amperage creep, Capacity creep, Technology optimization.

Computational Analysis of Mechanical Deformation in Aluminium Reduction Cell

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Abstract

The steel shell used in aluminium reduction cell/pot is generally subjected to the temperature range from 150 to 450°C, throughout the pot life, which ranges in 1800 – 3500 days. Exposure to such high temperatures for prolonged period makes pot shell susceptible to thermal expansion and creep mode of deformation. The excessive deformation always remains a key concern for pot-shell designers, as this may lead to premature steel shell failures. A rightly designed pot shell should operate for a complete duration of pot life without failure and it should be reusable for multiple generations of pot life with or without minor repairs. Hence, current study focusses on developing a computational model to predict the mechanical deformation of steel shell during cell life. Deformation of the pot shell assembly due to thermal expansion and creep have been analysed through rate dependent multi linear isotropic hardening and implicit creep model. This model was further used to assess the impact of the stiffener positions and thickness of shell on deformation.

Keywords: Hall Héroult cell, Steel shell, Deformation, Thermal expansion, Creep.

Innovative Online Busbar Repairing in Aluminium Smelter

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Abstract

Primary aluminium production involves electrolytic reduction reaction of alumina to aluminium, is a high-power consuming electrolysis process (almost 14 MWHr/MT of Al). Also in an aluminium smelter, several hundred (>300) electrolytic cells of production capacity ranging 3 to 4MT/day will be connected in series with a strong Aluminium Bus Bar Circuit. Flow of current is from Rectifier to Line bus bar to Anodes to Cathode via electrolyte (molten cryolite). In the overall circuit, there is an additional provision for bypassing current of one cell to the alternate cell without supplying current to the immediate cell. These bypassing shunts are kept boxed-up near Riser input bus point with an insulating plate between. In the due course of life of a cell, there are possibilities for few critical incidents that can damage the surface joints of contact areas. If found damaged, it is prescribed by the designer to do repairing back the surface in Zero Power mode across whole potline. Every time when line current is altered, there will be corresponding impact across cathode

lining of all cell's cathode and their life. Here in Balco, we wanted to mitigate this issue of repeated current alteration for this purpose and developed few strategic tools and procedures to overcome the abnormalities caused while rectifying another by ONLINE welding and repairing of damaged busbar and joints in the circuit.

Keywords: Aluminium smelter, Busbar, Compensating bus bar, Current reduction, Online repairing.

A Process to Recover Metallic Aluminum from Aluminum Dross Ensuring Zero Waste and Zero Discharge, Promoting Circular Economy

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Abstract

Aluminum dross is a hazardous/toxic waste generated in huge quantities in the Aluminum smelter plants. Every year, around 1 million tonnes of dross is generated globally as industrial waste. After recovering aluminum, the left-over dross goes to landfill, which is a major environmental concern. The presence of aluminum nitride (AlN) in the dross, when comes in contact with water, generates ammonia gas which is a health hazard.

The aluminum dross mainly consists of Al_2O_3, metallic aluminum, magnesium spinel ($MgAlO_4$), magnesium oxide (MgO), aluminum nitride (AlN) and traces of salt fluxes, chlorides, fluorides and others. Many methods (both pyro & hydro) have been developed for recovering aluminum, producing alum, refractories, etc. from the dross.

Runaya has come out with state-of-the-art and patented technology (M/s TAHA International) for aluminum dross processing wherein the waste is converted to value added product while recovering aluminum and manufacturing briquettes from the depleted dross (non-metallic particles) ensuring zero waste and zero discharge. The metallic aluminum (30 – 50 %) present in the dross is recovered in the first stage and recycled at smelter/cast house. The depleted dross lumps are further ground and left-over metal is separated from the non-metallic particles in the second stage. A binder is added to the non-metallic particles (NMP) and madeinto briquettes (Steel Slag Conditioners) in the third stage. The produced briquettes are used as steel slag conditioner for secondary steel refining process containing 60-70 wt.% Al_2O_3, 5-10 wt.% Al, 5-10 wt.% MgO, 5-10 wt.% AlN and remaining 5-10 wt.% contain CaO, SiO_2, FeO, etc. which reduce the melting temperature of slag, improve fluidity, de-sulfurization and other benefits, *thereby promoting circular economy.*

Keywords: Aluminum, dross, Circular economy, Steel slag conditioner and Sustainability.

Factors Affecting Properties and Performance of Carbon Anodes

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Abstract

Electrolysis cells use prebake carbon anodes for the production of aluminium metal. Carbon anodes are produced in captive carbon plants using calcined petroleum coke, coal tar pitch, and butts as the main raw materials. Anodes have a critical role in the operation of electrolysis cells. The requirement of carbon anode properties by high kA cells is very stringent, due to severe operating conditions at high amperage. The carbon anode properties are influenced by the properties of raw materials used and the process and equipment parameters at every stage of anode manufacturing. The baked anode properties in turn influence anode performance in electrolysis cells. For smooth operation of electrolysis cells, the use of optimum quality carbon anodes needs to be ensured. The understanding of correlations of anode properties with raw material characteristics and process parameters, and with anode performance in cells, gained through the operation of many high kA cell smelters, have been presented in the paper. The challenges of using deteriorating quality raw materials are discussed. These understandings help in adjusting the manufacturing process parameters and in the selection/blending of high and low S cokes to produce optimum quality baked anodes that will perform well in the high kA electrolysis cells.

Keywords: Carbon Anode, C.P. Coke, Dry Aggregate, Baking Temperature, Net Carbon Consumption.

Development of Bath Recycling Crushing Circuit for Anode Covering Materials.

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Abstract

Various types of grinding circuits with different types of size reduction equipment are used for production of bath in comminution process. The technology and process have changed with time in order to meet the needs of modern high amperage pot operation and bath plant operating at higher capacity. The close particle size distribution of anode covering material (ACM) is one of the vital parameters in pot operation. The target and achievable particle size distribution of different grinding circuits are discussed. The two major grinding circuits using air swept autogenous mill and the rotary breaker in most of the smelters are outlined with comparison of their advantages and disadvantages. The rotary breaker grinding circuits produces 0 to 16mm particles and are widely installed although the old circuits and air swept grinding circuits (0 to 10

mm particles) are still in operation. Operational aspects related to particle sizes in different process are discussed. The possibilities of reducing fines in the ACM in future plant is proposed.

Key words: Anode Covering Material, Bath Recycle Shop, Crushing, Air Swept Mill, Rotary Breaker.

Reduction In Specific HFO Consumption In Anode Baking Furnace

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Abstract

Anodes are critical component in aluminium smelting process. Anodes are made of CP coke, coal tar pitch and butt in Green anode plant. Baking is done in baking furnace to improve electrical Resistivity, mechanical strength and chemical reactivity to CO_2 attack & ambient air. Anode baking is the most critical stage of anode manufacturing process. The furnace is Heavy Fuel Oil (HFO) fired. The operation includes four stages namely preheating, heating, blowing and regulated cooling. The excessive consumption of fuel oil in furnace is a clear reflection of a hitch in operation and process. Moreover, it is major contributor of cost of anode production. The main causes for high fuel consumption were identified as deficiency in air supply for combustion, heating ramp stoppage and leakages from furnace walls. The primary focus was to increase the furnace draft. Modification in the blowing and exhaust ramp flexibles improved the furnace draft. The blowing speed was increased up to 105%. Automation was introduced in the heating ramps for auto start and cut off whenever required to ensure optimum use of HFO in baking. To reduce leakages from furnace refractories, tracking of the outflow points were done. The insulation layers were audited and repaired accordingly. Existing peephole covers of each section were replaced with modification.

The patching of the peephole rings was modified by high temperature castable. This ensured 100% sealing. Headwalls of the furnace were repaired wherever leakages were observed. Thermocouple, Zero pressure ramp (ZPR) were inspected and changed periodically. The specific HFO consumption was reduced **from 50.76 l/no to 44.44 l/no in Mar'2020.** Mass flow meter is installed in each heating ramp for tracking of HFO pulsing from every ramp. Digitization helped data logging into MES which made every drop of fuel oil spent in the furnace traceable. Further, thermal imaging and analysis is being done for improving energy efficiency.

Keywords: CP coke, HFO, Exhaust ramp, Heating ramp, Peephole covers, Headwalls.

Note: Sp. HFO consumption is normally expressed as Kg/mt. Hence, it **needs correction from 50.76 l/no to 44.44 l/no to Kg/mt of baked anode.**

Impact of Operational Parameters in Aluminium Cell: A Computational Analysis

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Abstract

Aluminium is produced from alumina through an electrolysis process, which is an energy intensive process with very low energy efficiency of about 45%. The rest of the energy is lost to the environment in the form of joule heat. The joule heat generated helps in maintaining the operating electrolyte temperature close to 950°C. The study focuses on analyzing the impact on thermal & electrical aspect of cell, by changing anode-to-cathode distance (ACD). Reducing ACD is always challenged by the electrolyte–metal interface instability. Therefore, first step should be identification of the scope of ACD reduction. Lowering ACD is also associated with reduction in heat generation, which will lead to changes in isotherm locations inside the cell. The location change of liquidus isotherm implies deviations in the thickness of cryolite freeze near the sidelining. Thicker freeze may interfere with the operational activities whereas critically reduced freeze thickness may lead to pot failure. Therefore, while modifying ACD, it is also required to make necessary changes in pot parameters to ensure a desirable freeze thickness on cell wall. A 3-D thermoelectric quarter cell model based on ANSYS was used to study the impact of ACD reduction. The parameters like line current, metal height and anode cover thickness were analyzed to facilitate this reduction, while regulating the heat loss, isotherm location, heat flux distribution to get the desired freeze profile and thickness.

Keywords: Thermo-electric, Isotherm, Specific energy, Metal height, Anode cover.

A Review on Specific Energy Consumption Reduction for Aluminum Production

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Abstract

Even though the basics of Hall-Héroult process have remained the same, the production technology has changed tremendously over the years, to reduce the production cost and specific energy consumption, increase in productivity and improved environmental performance. In this paper, the most notable innovations for the improvement of the Hall-Héroult process from energy savings perspective during the past 30 years have been described. It also details Hindalco's

achievements in the reduction of specific energy consumption over the years through developmental works and its best practices. The effect of different types of collector bars, high% Graphite Blocks, modified lining, Stepped-, and Ultra-Low Carbon collectors on the specific energy consumption of low amperage Hall-Héroult cell have been discussed.

Keywords: Aluminum production, Hall-Héroult cell, Innovations, Specific energy consumption.

Sustainable Operation of Anode Baking Furnace with Shorter Fire Cycle to Meet Customer Requirement

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Abstract

Manufacturing of anode in aluminum smelter includes three stages, namely, green anode production, baking of green anode and rodding of baked anode. Green anodes undergo baking process to remove the pitch volatiles, enhance its thermal and electrical conductivity, and reduce its reactivity level. Anode baking process is carried out in an open top ring-type furnace built up of high alumina refractory materials. The productivity of anode baking furnace is dependent on operation & maintenance practices, whereas the anode quality is dependent on the process parameters and its optimization. This paper presents and discusses the management of process, operational and maintenance practices to achieve the higher production by reducing the designed fire cycle without compromising Safety, Quality and Sustainability.

Keywords: Green Anode, Baked anode, Rodded anode, Pitch volatiles, Refractory Brick, Open top ring-type furnace, Fire cycle.

Production of Premium Grade P0303 Metal at Mahan Aluminium

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Abstract

Globally, customers consistently demand high purity grade metal and Mahan Aluminium, a unit of Hindalco Industries Limited, part of Aditya Birla Group (ABG), took up this challenge as an opportunity for new product development by initiating production of P0303 premium grade metal

ingots/sows. Mahan is consistently producing high purity grade metal beyond the regular grades and established itself as a preferred choice of world's leading customers of primary aluminium. Mahan Aluminium metal is also categorized as equivalent to "Good Western Metal" by some of our customers. For production of high purity metal, the chemical composition is a major quality attribute that controls product quality and adds extra value to aluminium produced. Mahan products have reformed the views of global customers for Indian aluminium by continuous quality improvements in all products. Our new initiative "Make in India" for manufacturing of aerospace and defense products encouraged us to foray into this premium segment. With continuous product quality upgrades, we have an opportunity to enter this segment and be a partner in nation building.

The methodology adopted for achieving this goal consists of understanding customer requirements, analysis of factors affecting hot metal purity, brainstorming, and raw material selection and blending to produce high purity metal. Further new process improvements, such as introduction of magnetic separator, usage of fresh tapped bath with alumina were carried out to obtain desired purity in metal for P0303. Dedicated pots to produce P0303 grade metal, shuttle planning, process improvements, monitoring and feedback enabled us to consistently produce P0303. This new product has enhanced our product portfolio and meets our client's expectations while showing the world that Mahan has the capability to produce high premium grade metal on a consistent basis.

Keywords: Mahan Aluminium, Aluminium purity, Premium grade P0303 aluminium, Hot metal purity.

Industry 4.0 for Indian Aluminium Smelters

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Abstract

The use of artificial intelligence and Digitization in manufacturing process is the necessity for today's industry. Industry 4.0 is the fourth industrial revolution which includes Internet of things, smart and autonomous computer-based algorithms to monitor and control the industrial process. JNARDDC took initiatives for implementation of Industry 4.0 in Indian aluminium Industry and developed Artificial Intelligence based system for anode butt monitoring, instrument for instantaneous and onsite measurement of vital bath parameters and a system for realtime measurement of anode current distribution of aluminium electrolysis cell. This paper presents the brief description of all three instrument/system developed and implementation of the same in Indian aluminium smelter plant.

Key words: Industry 4.0, Artificial Intelligence, Bath parameters.

Digital Transformation Journey at Vedanta Jharsuguda to Embrace Industry 4.0 Solutions

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Abstract

Traditionally manufacturing sector has always been a slow adopter of new technologies and modification due to involvement of high capex and high risk. Post industrial revolution operational efficiency was majorly focused on standardization, resource management and lean manufacturing. In 21st century, with emergence of technologies like AI, ML, Bigdata analysis, leveraging Data and hidden insights opens new scope for operational efficiencies and enforcing standardization.

Acknowledging and understanding the potential of digital technologies, Vedanta is adopting Industry 4.0 technological solutions in its operations proactively. Vedanta was the first in India and globally 2nd to implement Digital Twin based smelter operational advisory system at its largest Aluminium Plant at Odisha to significantly increase its operational efficiency, productivity and enhancing operational safety. The Industry 4.0 technology implementation like digital smelter powered by advanced analytics & ML is promising extended pot life, increased operational efficiency and reduced wastage. It is helping Vedanta to better operate, analyse and optimize its operation for higher sustainability.

Vedanta has taken Digital Transformation to its plant operation eco-system. It has implemented IOT based logistic control tower for better planning, scheduling, and securing of its raw material transportation leading to supply-chain efficiency. Vedanta is also looking for predictive maintenance solutions like APC, APM for its rectifier and smelter operations and visual analytics for early defect identification and enforcing safety protocols. Vedanta understands that data layer is essential for deploying current and future emerging predictive, prescriptive solutions. Hence, we are implementing next-gen historian platform for smooth, and efficient data collection and management. At Vedanta people are our key assets and success for any transformation journey lies with their grooming. With that in mind, Vedanta is equally focusing on upskilling and reskilling its resources on cutting edge technologies for maximum adoption and sustenance deployed technological solutions.

Key Words: Digital Twin, IoT, AI/ML. 4IR, Predictive maintenance, Visual analytics.

Impact of Feed Quantity on Pot Performance

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Abstract

Contemporary aluminum smelters have been using point feeding technology to feed alumina in the electrolytic bath to maintain the concentration between 2 to 4 wt.% (optimum range) in the electrolyte. At low alumina concentration (<2%), cryolite decomposition occurs and perfluorocarbon (PFC) gases evolve, resulting in an anode effect (AE). High AEs significantly increase the specific energy consumption and affect pot life. Correspondingly, at the high alumina concentration (>4%), the alumina dissolution rate decreases, which leads to increased sludge forming tendency, thereby, the pot voltage and instability increases. Due to the manually intensive operation and variation of the technical parameters such as bath temperature and bath ratio, most of the smelters face the major challenge of maintaining the alumina concentration in the optimum range. Hirakud 85 kA potline has been running with two feeders, each with a discharge weight of 1.8 kg/feeder. Pots with these feeders were observed to have higher sludge forming tendency and high AEF, as finer control of alumina concentration is difficult. For improving the Al_2O_3 control and to understand its holding capacity, feeder size was reduced from 1.8 kg/feeder to 1 kg/feeder and its trial was carried out in one pot along with modification in feed control logic.

This study would describe the changes in hardware and feed control logic for a reduced feeder weight (1 kg/feeder) using a PLC-based pot controller. It will also present results of trial in one pot, for a duration of four months. The average AEF of 0.24 per pot/day was achieved, as compared to AEF of 0.5 per pot/day for conventional feeder (1.8kg/feeder).

Keywords: Feed discharge, Feed strategies, Alumina concentration, Anode effect frequency, Anode effect duration.

Operation Excellence in Potlines of Aluminium Smelters

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Abstract

Achieving high % Current Efficiency with low Specific D.C. Energy is the primary criteria of every Aluminium Smelter around the world. Operating pots with low temperature (953±2°C) while keeping other parameters in the operating zone is the key for increasing aluminium production. Pot Voltage cannot be reduced until unless anode/cathode drops are reduced. So far, use of slotted carbon anodes and use of graphite cathode blocks attributed for low voltage drop in the pots. In aluminium pots, metal produces metal, high metal level operation in the pots can give high current efficiency. In aluminium smelters, current efficiency >96% in the present era is achievable if pots are operated with high metal and maintained excess AlF_3 >11%. High excess %AlF_3 in pots neutralizes sodium (Na) and it breaks the sodium chain responsible for electronic conductivity. Presence of high excess AlF_3 reduces aluminium metal dissolution in bath at bath metal interface. If current efficiency is high then pots can be operated with high voltage without affecting Sp. D.C. Energy. The role of % current efficiency in reducing Sp. D.C. Energy consumption is much higher than the role voltage. It is misconception in many smelters that Sp. D.C. Energy can be reduced by reducing pot voltage through squeezing the ACD (anode cathode distance). Pot voltage cannot be reduced without addressing to reduction of anode/cathode/bath drops. Squeezing ACD can only results in loosing current efficiency and more heating up of the pots.

Keywords: Current Efficiency, Specific D.C. Energy, Aluminum Fluoride, and Metal Height.

Restart of Potlines after Prolonged Power Failure

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Abstract

Facing D.C. Power reductions/shutdowns has been a normal phenomenon in all Aluminium smelters. Aluminium smelters having uninterrupted power supply operates very healthy pots with high Current Efficiency. For higher aluminium production, higher KA pots are preferred these days. Number of pots in operation should be decided based on uninterrupted power availability.

It is better to stop the pots and solve the power issues rather to operate pots in uncertain power conditions. Captive power sources connected to national/state grids with varying power loads are highly sensitive to total tripping. Coal based captive power sources needs to maintain sufficient buffer stock of coal for providing uninterrupted power to smelter plants. High cooling tendency because of high sigh surface area in the pots reduces chance of keeping heat for prolonged periods in zero power situations. It is obvious that higher KA pots have bigger pot size, less ledge thickness and prone to high heat losses. So, holding heat in pots for longer period is not possible in prolong power failures. Restarting potlines in cold condition after prolong power failures will take much longer time and results in loss of production. Good team with proper planning is key to restart/survival of the pots after prolonged power failures. Bypassing the pots having high anode failures and simultaneously resuming rated KA in quick possible succession period can save more pots after prolonged power resumption.

Keywords: KA (kilo ampere), Current Efficiency, Uninterrupted power supply, Potlines, Captive power source.

Reduction in Dead Pot Voltage in Aluminium Smelter

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Abstract

Primary aluminium production consist of electrolytic reduction of alumina to extract pure aluminium which is highly power intensive process. Unlike other metal extraction processes, aluminium production smelters comprise of several electrolytic cells connected into series by virtue of aluminium bus bars circuit.

Current flow direction is from rectifier to potline bus bar to pot risers to anodes to cathodes through electrolyte (molten cryolite) and then again to bus bar. In over all circuit, there is an additional provision to bypass the current in the event of pot cut out which are compensating bus bars. After pot cut out, current flows from these compensating bus bars and thus, the cut put pot (dead pot) experiences some residual voltage. This voltage does not take part in metal production hence, it is not required and should be minimized.

To reduce the voltage of dead pot, alternative routes are explored for current flow having lower resistance coupled with higher cross sectional area. In order to implement this, a new tool and process has been designed and developed.

Keywords: Aluminium smelter, Busbar, Compensating bus bar, Dead pot.

AO Digital Dashboard Using Power BI

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Abstract

The biggest part of the digital transformation is changing the way we think. The project of AO (Asset Optimization) digital dashboard is responsible for tracking **AO KPIs** (Key Performance Indicators) and **Asset integrity compliances**. Under the project, all the manual activities of extracting data from **SAP** and manual calculation of KPIs and tracking are eliminated and digitalized. The AO digital dashboard will help the AO practitioners to track the AO KPIs in real time without any manual interventions and in standardized form.

It consists of the following key features:

1. Daily Asset Management Report- Daily online update on key asset management KPIs by plant and department level and can be drilled up to equipment level.
2. Preventive Maintenance Dashboard- Tracking and Review the various aspects of Preventive Maintenance (Schedule Compliance, One Day Compliance, Ideal Time Compliance and Task List Compliance) in Plant/SBU (Strategic Business Unit) /Department/Functional Location level.
3. **RCA** (Root Cause Analysis) Dashboard- Online tracking and analysis of Department Wise RCA Compliance, RCA Coverage with respect to breakdowns and RCA CAPA (Corrective action Preventive action) implementation.
4. FMEA (Failure Mode Effect Analysis) and CA (Criticality Analysis) Dashboards- Online tracking of CA/FMEA compliance for departments and status of planned actions. Further drill down can be done up to equipment/action level.
5. **CBM** (Condition Based Monitoring) Dashboard- Live status of CBM compliance, status of corrections against CBM abnormality and tracking of planned actions to rectify the CBM observations.
6. Break Down Pareto/Trend Analysis- Online pareto analysis of breakdowns in department level/Equipment Level and up to cause level will help users to identify the repeated breakdowns and causes and its rectification.
7. CAPA Ageing Report- Enable users to track and timely implement the Planned Corrective and Preventive actions against various asset strategies and **RCAs.**
8. Maintenance Cost Analysis- Planners and Maintenance crew easily track the spare cost booking under department, Work order till equipment level and optimize it.
9. Effectiveness Report- Analyze the effectiveness of various asset strategies will help users to improve the implementation and revise the asset management strategy.
10. AlF_3 Analysis Report- Real Time analysis of Pot /Section and Room wise **ALF_3 consumption**, Deviation Tracking of various pot parameters.

11. Green Anode Parameter Analysis- Real Time Analysis of anode wise parameters (Ball mill fraction, Coarse Coke, Coarse Butt, Cooler Power, Dry Mix temperature, Kneader speed and kneader torque, Paste Temperature, Pitch temperature, Anode height and Weight).

Keywords: AO KPIs, Asset integrity compliances, SAP, RCA, ALF_3 consumption, CBM.

ALUMINIUM DOWNSTREAM

Additive Manufacturing Process for Manufacture of Al parts and Molds for Al Manufacture - An Overview

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Abstract

Additive manufacture (also called 3D printing) is a relatively new downstream manufacturing process for producing intricate high quality functional parts and rapid prototypes in aluminium and other metals. Also used in producing inserts used in direct metal injection and Al extrusion processes. There is no need for mould and any additional tooling. It is possible to build internal features and passages that are impossible to manufacture in conventional manufacturing routes. Several 3D printing technologies exist, so called PBF (powder bed fusion) based technology is most common. 3D printing is gaining widespread acceptance and has seen fast growth in the last few years. This paper covers following topics: introduction to various metal 3D printing technologies, advantages and limitations, alloys used, physical metallurgy, microstructure differences, comparison of engineering properties, and typical applications.

Keyword: Additive manufacturing, Powder bed fusion (PBF), AlSi10Mg, Pressure die casting, Aluminium extrusion, Metallurgical properties, Al 3D printing applications, Mould inserts.

Development of 65032 Alloy in Billet & Successful Customer Qualification

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Abstract

Owing to successful usage of aluminum alloys in sectors like automotive, aerospace, defense, construction, etc., it is finding enormous potential to substitute products due to its Light weight and other material characteristics advantages over copper and steel without compromising the product performance usage and enhancing its performance attributes. Aluminum alloy development and its usage is increasing at a fast pace with extensive research approach in the modern technology. Vedanta is one of the elite producers of aluminum billets of different alloys (1xxx, 3xxx & 6xxx) in the current competitive aluminum industry on global front. Vedanta being the largest producer of Aluminum Billets in India has always work in tandem with Customer and

understand their requirements as per the developments in market. One of our esteemed Indian customers had approached us to produce 65032 alloy but it is a new alloy for us. This alloy is used for extrusion of rods, forging for production of automobile yoke, transmission shaft application in passenger vehicles. In order to diversify our market segment, Vedanta took an initiative in developing this new alloy. Team has been formed for building the capacity to produce this new aluminum alloy that can cater to Automotive applications. Team had conducted several brainstorming sessions to encounter the technical difficulties that could arise during the production of this special alloy casting, furnace alloy preparation, discussed with OEM, developed casting Recipe, set all the process parameters and established Homogenization cycle based on our technical expertise. This paper briefly discusses on the technical characteristics and process design aspects that were initially established in the production of 65032 alloy and further harmonizing them with the customer's technical feedback of our initial supply lot, thereby achieving the culmination on being ratified by the customer in production of 65032 alloy. This new Alloy was successfully Qualified by the Customer with respect to Excellent extrudability and desired product characteristics thereby fetching an additional premium over regular Alloys.

Keywords: Aluminium alloys, Aluminium billets, Automotive applications, Customer's technical feedback.

Improved Energy Savings as well as Reduced Emissions Using Water-in-oil Nano-emulsions in Aluminum Calciners and Bake Ovens

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Abstract

Industrial combustion applications of liquid fuels are mainly achieved through spray atomization (atomized liquid fuels into fine fuel oil droplets). The particle size and penetration distance of the droplets are the important parameters in spray flow fields. The size of the droplet should be small enough to be rapidly vaporized; on the other hand, the size should be sufficiently large for the droplet to have an opportunity to penetrate deep inside of the combustion chamber. However, for most efficient combustion, oil droplet size needs to be further reduced. To achieve this reduction in oil droplet size, nanotechnology is used to introduce nearly a million water droplets within each oil drop resulting in a water-in-oil nano-emulsion.

The emulsified fuel droplets are heated by the surrounding high temperature during the combustion process. When the internal water droplet temperature exceeds its superheat limit temperature, the water gasifies rapidly, and the emulsified fuel droplets are then split into smaller droplets, which is called a micro explosion.

When the emulsified liquid is used as a fuel, the first step of atomization is usually achieved using a spray nozzle. The second stage of atomization is performed by the occurrence of the micro explosion when the droplets enter the high temperature combustion chamber. Consequently, the droplets explode into tiny droplets (i.e., secondary atomization) that can be rapidly vaporized and

effectively combusted. This process improves the formation of the combustible mixture as well as combustion efficiency to save energy. Another advantage of the emulsified fuel is that the moisture contained in the fuel absorbs heat, which lowers the tip temperature and thus reduces the formation of thermal NOx. In addition to reducing NOx emissions, the emulsified fuels formed by the fuel–water mixing technology gain the emission advantages of other pollutants such as carbonaceous residues in the combustion furnace due to the micro explosion behavior.

Water-in-oil nano-emulsions simultaneously reduce emissions of both the oxides of nitrogen and particulate matter as well as achieving significant cost savings. During actual production runs in manufacturing plants in India, cost savings ranging from 7-10% as compared to specific fuel consumption with HFO & LSHS have been observed in Anode Bake Ovens as well as Aluminium Calciners.

Keywords: Spray atomization, Water-in-oil nano-suspension, Combustion chamber, Cost savings.

Effect of Rare-earth Elements on Structural Stability and Mechanical Properties of Aluminium Alloys

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Abstract

The effect of micro-alloying rare earth element cerium on the microstructure and mechanical properties in Al–Zn–Mg-Cu alloy have been investigated. In this study, aluminum alloys have been prepared by melting and casting followed by thermo-mechanical processing. The alloys were extensively characterized for microstructural and mechanical property. The microstructural study revealed the uniform distribution of fine GP zones and some semi coherent β(MgZn2) precipitates in the Al rich matrix. Further TEM results show that when the Ce content was changed from 0.1% to 0.4%, precipitate size increased from 4 to 45 nm and the precipitate morphology changed from spherical to needle shape. Evaluation of mechanical properties through tensile and hardness tests have exhibited that both hardness and tensile strength increases with Ce addition up to 0.3% and subsequently decrease.

Keywords: Thermo-mechanical processing, Precipitate morphology, Tensile test, Grain size, Hardness, Aging.

Effect of Ram Speed on Evolution of Peripheral Coarse Grain During Extrusion of AA2024 Alloy

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Abstract

AA2024 alloy has comparatively higher content of alloying elements and productivity of this alloy is about one tenth in comparison with soft/medium strength alloys. The phenomenon of peripheral coarse grain (PCG) defect formation limits the usage of this alloy and PCG is highly dependent on alloy chemistry and operating parameters during extrusion. In the present work, a solid bar of AA2024 alloy with an extrusion ratio of 50 was produced on 1400 tonne extrusion press with varying ram speeds (0.3 to 1.2 mm/s). Extrudates were heat treated and characterized to observe the effect of ram speed on peripheral coarse grain (PCG) formation. Results have indicated that at low speeds (0.3 mm/s), PCG defect was not evident, whereas PCG was observed at higher ram speeds. This technical paper describes the microstructural evolution in AA2024 alloy during extrusion.

Keywords: AA2024 alloy, Ram speed, Peripheral coarse grain, Aluminium extrusion.

Production and Certification of Certified Reference Materials for AA 6063

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Abstract

Certified reference materials (CRMs) used for spectro-chemical analysis of aluminium alloys or any other metals are reference materials with certificate that provides the weight percentage values of elements present in the CRM with associated uncertainty and a statement of metrological traceability. For the spectrometer to deliver a quantitative chemical analysis from the wavelength and intensity data, these measured values are required to be compared with CRMs. Hence, CRMs are crucial for validation of a method and calibration during spectro-chemical analysis and for assessing instrument's performance and laboratory proficiency. For aluminium alloys, CRMs are majorly imported as domestically available CRMs does not cover wide range of aluminium alloys. With a vision to substitute the imports of CRMs, initially at JNARDDC we attempted to produce grade specific CRM i.e., AA6063 which is very widely used for various extrusion applications in several sectors. Homogeneity is an important requirement for any CRM to ensure that each CRM

unit carries the same value for each property, i.e., weight percentage of elements present in the CRM. After extrusion and machining to produce discs, sampling and homogeneity assessment was carried out as per ISO Guide 35 using in-house Spark-OES. This paper discusses about production of candidate CRMs of AA6063 through extrusion, its homogeneity analysis, traceability and certification procedures for CRMs as per the requirements mentioned in ISO 17034.

Keywords: Certified reference materials, Spectro-chemical analysis, Aluminium alloys, Homogeneity, Traceability, Certification.

Rising Scope of Aluminium Recycling in India

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Abstract

Environmental sustainability is integral to the existence and growth of any manufacturing industry. Secondary aluminium is essential to the industry's survival because even new metal often requires the use of an optimized combination of recycled materials. In most countries, there exists a well-established market for recycled aluminium with firmly defined distribution chains. India is yet to emerge in a big way as an aluminium recycling country. Given the fact that India's per capita consumption of aluminium is still one of the lowest at 3 kg against a world average of ~11kg, with 22-25 kg in developed nations, it will be too early to call it a day, but the area of concern here is the complete lack of structure for aluminium scrap handling and secondary metal recovery. India's metal recycling rate is just about 25%. All the activities related to aluminium scrap recovery are limited to the unorganized sector, catering mostly to the utensil and casting industries. The aluminium recycling business needs awareness among various participants within the metals ecosystem and requires monitoring and promotion from the government. If India increases the percentage of recycled metal from the existing of 20-30% to the world benchmark of 45%, it will be able to conserve 8 lakh tones of bauxite reserves every year!

Secondly, making a transition to aluminium scrap recovery and recycling to generate more metal for reuse will help the country to cut down on its yearly power consumption substantially.

Consumption of aluminium foil, beverage cans, and other packaging is rising steadily, thanks to growing urbanization and changing lifestyle of people in India. Hence, to keep the surroundings clutter-free, it is necessary that these domestic wastes are collected and treated properly for sustainable reuse purposes.

Finally, an organized scrap industry will help create employment opportunities opening up scope for entrepreneurship, skill development, and enhancement of overall safety standards that is presently lacking in the unregulated sector. Further vehicle scrappage policy formed by the government of India will also give boost and encouragement to this industry.

Ramp up of Production and Quality Improvement Journey of Alloy Ingots for BALCO

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Vedanta being the first primary smelter to launch Primary Foundry Alloys (PFA) in 10 kg from BALCO going into wheel manufacturing in Automotive Industry. Holding a domestic market share of 35% among Primary Aluminium Producers committed to meeting world class quality standards with state-of-the-art Bafesa (Spain).

BALCO is approved supplier from more than 20 domestic wheel manufacturers & Original Equipment Manufacturers (OEMs) and continuously expanding the reach to leading automotive brands. The main aim of this paper is to elucidate over BALCO as a leading manufacturer of PFA in India and its journey of establishing quality & enhancing productivity in domestic market. The inception on this development initiated in 2016. Later in 2017 pilot lots have been introduced in market, with the growing time, demand and need for operational excellence, the productivity and quality sustenance were the key factor for the overall growth of the foundry alloys.

With 4-5% CAGR (compound annual growth rate) increase in demand of primary foundry alloys globally, there was rising demand to diminish the supply demand gap, the throughput of the machine had to be improved. There is always a challenge to ramp up production maintaining quality requirements as per standard. On increasing the production level there were rising instances of oxide formation, improper surface finish, uneven sizes of ingots & entrapment of impurities, resulting which the productivity had to decrease by 25% which again resulted in loss of machine utilization.

With right troubleshooting, analysis and corrective measures in process and operating procedures, there has been decrease in rejection from 2.2 to 0.9% which resulted in radical reduction in customer grievance by 80% Y-o-Y. Considerable improvement done in metal hygiene by reducing metal turbulence, use of special grade cleaning agents and launder coating material, increasing hot cleaning frequency to prevent erosion and thus accumulation of impurities in the input metal. 100% compliance in online degassing & change in frequency of CFF with complete automation and introduction of interlocks were the key actions. Strict control over CTQ (Critical to Quality) parameters during metal pouring, preparation & casting. The TAT has also been improved by 63%, thus improving the homogeneity of the metal. Currently there is also a modification in the design of ingots to ensure proper stacking and bundle integrity.

All the major improvement steps towards enhancing productivity keeping quality standards as per automotive requirement (meeting IATF standards) resulted in customer satisfaction and Balco as a preferred brand.

Keywords: Primary Foundry Alloys (PFA), Automotive industry, Increase in demand, Enhancing productivity, CTQ parameters.

alumina
CHEMICALS & CASTABLES

ALUMINA TRIHYDRATE (ATH) (FIRE RETARDANT)

Used as a major and cost effective FR filler in All kinds of Rubber compounds, pigment in paints, filler for bond paper, SMC / DMC / FRP / PVC (FR & FRLS Compounds)

SODIUM ALUMINATE

Used in manufacture of for paper sizing & water purification (water softening) chemicals, construction chemicals for fast setting of concrete, Environment friendly alternate to phosphates in detergents.

CALCINED ALUMINA

Used in manufacture of ceramic tiles, enamel, ceramic frit, glazed tiles, industrial polishing & buffing compounds (Polishing green Soap), ceramic fibre (insulation), refractories, castables & high alumina cements, technical ceramics components and kiln furniture.

ACTIVATED ALUMINA

Used as Catalyst for petrochemicals for sulphur removal, adsorbent for refrigeration industries, dessicant for dryers and water purifiers.

ZIRCONIUM SILICATE

Used as opacifier in ceramic industries.

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