INTERNATIONAL SYMPOSIUM 2016

IBAAS

SEPTEMBER 26-28,2016
RADISSON BLU HOTEL & RESORT
SOUTH GOA

ALUMINIUM INDUSTRY

THE EVOLVING ASIA-PACIFIC STORY

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ABSTRACTS

WELCOME NOTE

On behalf of the organizing committee, it is our pleasure to welcome you in the IBAAS-2016 Conference on ***"Aluminium Industry- The Evolving Asia-Pacific Story"*** being held in Goa from September 26-28, 2016 with special session on Energy Reduction in Aluminium Smelting, Jointly Organized with Indian Institute of Metals (IIM).

The 5th International IBAAS 2016 Symposium is being held with the following objectives:

- To Reduce Energy in Aluminium Smelting Industry and Develop a Road Map for Aluminium Smelters in India
- Provide a platform to the attendees to share knowledge and review latest developments in the entire value chain of Aluminium Industry
- Technology up gradation and research work in the field of Alumina, Aluminium, Carbon products and electrodes, downstream products
- Application of Bauxite and Alumina for non-metallurgical uses
- Recycling Industry and its contribution
- Critical drivers for entire chain of Aluminium Industry -Energy & Environment
- Waste (including SPL) disposal management and deriving value from waste

We welcome you to this mega Aluminium event in India and are confident that you all will benefit from this opportunity to interact with industry leaders, experts and professionals participating in this International conference.

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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:

- Provide platform for Aluminium industry professionals to interact and network for the common goal and development of this industry
- Organize annual and bi-annual workshop, seminar and conferences in association with primary Aluminium producers, Engineering and R&D Institutes
- Promote latest technology and advertise products and equipment.
- Publish, papers, monographs and books to highlight latest achievements in the field
- 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 Asian region. The Society has since then organised 4 International events in India and China, details are given below:

- **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).

The above four International events were highly successful and evoked wide interest of Aluminium industry and experts in the IBAAS symposium and conferences. In continuation of above four conferences, this year IBAAS is organizing fifth International event (**IBAAS-2016**) in Goa, India during September 26-28, 2016.

ASSOCIATED ORGANIZERS of IBAAS 2016

The Indian Institute of Metals is a premier organization representing materials and metallurgical engineers in India. Founded in 1946 by a group of metallurgists led by Dr. D.P. Antia, IIM is the largest professional organization for metallurgist in India with over 8000 members from R&D laboratories, academia and industry. The two main objectives of IIM are: promoting and advancing the science and technology of metals and alloys and protecting the interests of metallurgists and metallurgical industry.

Jawaharlal Nehru Aluminium Research Development and Design Centre, is an autonomous body under ministry of mines, Govt. of India. It is a "center 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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Indian Institute of Chemical Engineers is a confluence of streams of professionals from academia, research institute and industry. It provides them the appropriate forum for joint endeavors, hand-in-hand, to work for human being through application of chemical engineering and allied sciences. If you are interested about, attached to or involved in chemical engineering related activities, whether

as a student as a seasoned professional - you shall find the program of IICHE immensely beneficial, opening up doors of new possibilities and existing possibilities.

China Aluminum International Engineering Corporation Limited (hereafter referred to as CHALIECO), established on the December, 2003, is the 4th business section of Aluminum Corporation of China (CHINALCO) – Engineering Technology Section and appeared on Hongkong Stock Market on the July, 2012. CHALIECO has five design & research institutes of National Grade A and 5000 engineers who have rich experiences and constitutes one team full of creativity. It owns five construction enterprises with rich experiences of engineering construction on nonferrous metal industry.

Roskill has been a leader in international metals and minerals research since starting life as one of the UK's first management consultancies in 1930. Since the first Roskill Reports were published in 1970, our list of publications has grown to over 75 market reports, data books and newsletters.

Our clients use our published research and consultancy services for a wide variety of purposes formulating company strategy, following industry trends, planning exploration and marketing activities, competitor analysis, training new staff and gaining a complete overview of a single industry.

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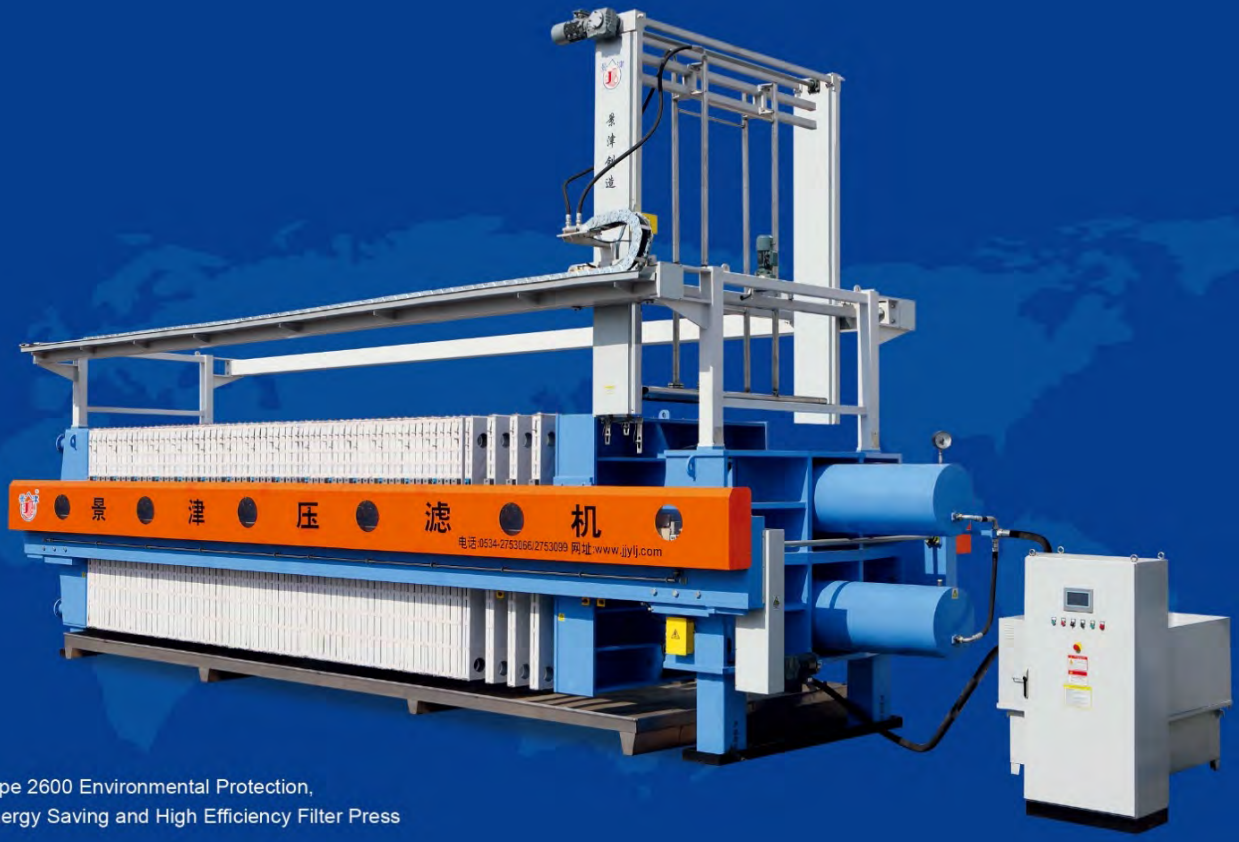

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SECTION – I
ABSTRACTS

BAUXITE – ALUMINA

Developing Bauxite Projects – Planning for Quality Product

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Abstract

The development of bauxite projects is focused primarily on such important aspects as in-country available infrastructure, logistics, mineral processing, or deposit geology. These disciplines play an important role by having significant impact on project economic viability, technical feasibility or the capacity to raise funds for project development. Nevertheless, when all these important aspects are finally determined, the project still needs to deliver quality and profit-generating product, therefore a study should be undertaken to incorporate appropriate mine planning techniques to determine the product quality range. It should define the bauxite product quality achieved from the deposit over the Life of Mine period and how this aligns with the project's strategic objectives in terms of project minimum mine life or head grades. Some fundamental factors, known as Mining Modifying Factors, will influence the production profile and hence should be appropriately incorporated to the study at an early stage. These modifying factors include mining dilution and recovery, processing recovery, cash costs, and their effect on the economic value of a mining block. They are inherently linked to the deposit characteristics, the mining method to be applied, in situ grades, strip ratio, and other technical or economic characteristics influencing the quality of the final product.

Keywords: Bauxite quality; bauxite mining; mine planning; production planning; losses and dilution, margin ranking

Why Guinea Bauxite is considered Best in the World?

Ashok Nandi
Secretary IBAAS & Geological Consultant

Abstract

The Guinea, a small West African country, is endowed with more than 40 billion tons of metallurgical grade bauxite and thus occupies the top position in the world. Despite being blessed with world's largest bauxite deposits, till recently Guinea was lagging behind in bauxite production compared to major producing countries like Australia, Brazil, China and India. However, the scenario is fast changing now with the entrance of Chinese, Abu Dhabi and Russian companies. One of the interesting features of Guinea bauxite is the natural low reactive silica content (<2%), which makes this most favourable for alumina production in the world. Further, lateritic bauxite of Guineais basically gibbisitcin nature with less than 2% boehmite, absolutely suitable for low temperature alumina refinery. Although from alumina processing point of view, Trombetas bauxite of MRN, Brazil is considered the best in the world, however, this is beneficiated washed ore with comparatively higher cost in the world market. In the present

paper, Guinea is compared with leading bauxite producing mines of the world with reference to its Geology-Geomorphology, Resources, Chemistry-Mineralogy, Mining and Alumina processing point of view.

Characteristics of West coast (Goa) Laterite and Possible Techniques for Up-gradation

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Abstract

The vast laterite deposits are located in western part of the Country which covers an area of Maharashtra, Goa, Karnataka and Kerala States. JNARDDC have been evaluated laterite deposits of west coast and studies shows that laterites are low in alumina and high in iron, silica content. The characteristics of laterite as well as bauxite vary may be due to the factors such as composition of parent rock, origin, lateritisation process, etc. of a particular deposit. The beneficiation studies carried out on representative samples of Goa Laterite. The studies carried out with an aim to reduce iron and silica content as well as enrichment of alumina. It comprises techniques such as magnetic separation, hydrocyclone and flotation. The beneficiation studies indicated that the iron and silica can be reduced by adopting certain techniques.
In this paper an attempt is being made to focus on salient characteristics of Goa laterite and various beneficiation studies carried out at JNARDDC for reduction in iron, silica and enrichment of alumina content. The paper also covers the significance of a relevant methodology / techniques.

Key Words: Laterite, beneficiation, physical separation, hydrocyclone, flotation

Premium Alumina Solutions for Modern Steel Making

Marcel Spreij[1], Andreas Buhr[2], Sarbapi Mukherjee[3], Shankha Chatterjee[3]

1. Almatis B.V.
2. Almatis GmbH.
3. Almatis Alumina Pvt. Ltd. India

Abstract

Over many decades, the iron and steel industry is continuing to undergo continual changes in its product quality due to increasing demand of varieties of ultralow carbon steels or alloy steels. These special grades of steels have much lesser amounts of carbon, sulphur, oxygen, hydrogen, nitrogen and other non-metallic inclusions. Thus it developed the need of aggressive operation parameters in secondary metallurgy such as high casting temperatures, purging pressures, severe slag chemistry etc. To cater such severe steel operational demands as well as to achieve higher

refractory service life, there is an increased need of synthetic alumina (neutral/ inert) raw materials which are much consistent and homogeneous in quality than natural or mined and fused raw materials. In addition to the metallurgical advantages, alumina refractories show benefits in clean steel production in different ways like no re-oxidation and no carbon pick up in ultra-low carbon steels as well as provides flexibility of refractory lining concepts for producing different grades of steel. The low thermal conductivity of alumina refractories when compared to carbon containing basic materials leads to significantly lower heat losses in steel ladles. The cost for such heat losses can be more than 50% of the ladle refractory cost. The non-hazardous synthetic alumina solutions (like chrome free/ fiber free/ CO_2 emission free) as well as recycling options of premium alumina solutions provide additional benefits to the end users.

ALMATIS, being the world's leading producer of alumina based materials for refractory, ceramic and polishing applications, concentrates fully on manufacturer's role as superior quality producer of synthetic premium alumina products having primarily tabular alumina, sintered magnesium aluminate spinels, calcium aluminate cements, calcine & reactive aluminas and dispersing aluminas in its product portfolio. The new developments in high alumina refractory industry are arising to cater the various needs of iron & steel makers. These premium alumina products not only provide certain specific enrichment of refractory properties but also require precise understanding of application's critical properties and appropriate refractory manufacturing formulations and application understandings. ALMATIS, with its series of specialty premium aluminas available globally, offer suitable solutions to the refractory industry in order to meet the stringent demands of modern day steelmaking. This paper discusses examples how value added and engineered synthetic premium alumina products contribute to fulfill the emerging needs of modern steel making.

High Purity Alumina of Altech Chemicals

Iggy Tan
Altech Chemicals Limited, Australia

Abstract

Altech Chemicals Limited (Altech/the Company) is aiming to become one of the world's leading suppliers of 99.99% (4N) high purity alumina (Al_2O_3) through the construction and operation of a 4,000tpa high purity alumina (HPA) processing plant at Johor, Malaysia. Feedstock for the plant will be sourced from the Company's 100%-owned kaolin deposit at Meckering, Western Australia and shipped to the processing plant in Malaysia. Altech's production process will employ conventional "off-the-shelf" plant and equipment to extract HPA using a hydrochloric (HCl) acid-based process. Production costs are anticipated to be considerably lower than established HPA producers - in the bottom quartile of the production cost curve. The Project is a high margin, high value proposition, requiring a relatively low level of capital investment.
HPA is a high-value (US$23,000 per tonne) high margin and highly demanded product, as it is the critical ingredient required for the production of artificial sapphire and in the manufacture of large format lithium-ion batteries. Artificial sapphire is used in the manufacture of substrates for LED lights, semiconductor wafers used in the electronics industry, and scratch-resistant artificial

sapphire glass used for wristwatch faces, optical windows and smartphone components. There is no substitute for HPA in the manufacture of artificial sapphire. Lithium-ion battery manufactures require HPA as a coating for the plastic anode/cathode separator to reduce separator shrinkage and combustibility. Global HPA demand is approximately 19,040tpa (2014) and demand is growing at an annual rate of 28%.

Development of Sintered Alumina & Its Application in Ladle Refractory Lining

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Abstract

Optimizing energy efficiency & longevity of ladle refractory lining has led to continuous efforts be devoted to searching for the next generation of refractory materials among which tabular alumina has been drawing more attention for its highly recognized performance. Nevertheless, current research is focusing on expanding the family of sintered alumina in response to a variety of applications issues that could not be fully addressed by tabular alumina otherwisely. Castable consisted of sintered micro-porous alumina indicates a lower thermal conductivity, comparable mechanical strength, and slag corrosion resistance in comparison of tabular-alumina made materials. Sintered dense alumina based castable can significantly reduce erosion and wear caused by molten steel, thus minimizing repair work for ladle bottom. Sintered zirconia-alumina helps to improve the slag corrosion resistance & thermal shock resistance of sliding plate and purging plug.

Specialty Alumina: Non Refractory Applications Require Purer and Finer Products with Cost Effective Solutions

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Abstract

Specialty alumina market for non-refractory applications has been dramatically changing in the past ten years. From a relatively simple technical proposal based on a stricter control of **chemistry** and **particular size distribution**, it has shifted to a customer request for more focused or even tailor-made products.
The range of applications is widening constantly in a market where the number of producers is also increasing continuously.

Under a price pressure that is bringing part of the business to a more commodity oriented market on one-side, on the other side the request for purer and finer products is increasing especially for new-technology segments.
Integrated bayer-based producers and more niche producers are trying to address this shift in a more **environmentally constrained** situation, leading to major changes in the industry.
On the product side, customers are requesting a level of impurity control that is new for this segment of the industry. Soda level control is far from being the only challenge to be achieved and requests for lower than few ppm level on other metals are getting on board, questioning the ability to achieve this **purity** requirement in a traditional bayer environment.
Particles are not looked at anymore only on size distribution point-of-view but also on a **crystal** size requirement and grain shape requirement that will impact the customer's process.
This shift requires a better understanding by the producer of the final applications, in an industry where customers are concerned rightfully of IP protection.
The challenge is for the producers to reach those requirements with a **cost effective** solution in a market where players from emerging economies have still to proof their know-how.

Importance of Bayer Process R&D for Speciality Alumina Business

S Sankaranarayanan

Abstract

R&D is important for any industry, especially for a manufacturing industry. Speciality alumina business, with applications ranging from aluminium chemicals, fire-retardant fillers in plastics and rubber, shaped and castable refractories, wear-resistant, insulating and other high-end ceramics, glass, polishing etc, thrives on the three pillors of R&D namely, product development, application development and application engineering. There are numerous products with specific properties to cater to these wide ranging applications.

The basic feedstock for the Speciality alumina business is the alumina tri-hydrate (ATH) produced and supplied using the more than century-old Bayer Process. There are a number of value drivers for the Bayer Process, which not only influence Metallurgical alumina meant for smelting into aluminium metal but also the Speciality alumina business. R&D plays a very important role in shaping and controlling these drivers.

This paper illustrates the role of Bayer Process R&D on the Speciality alumina business.

Keywords: Speciality alumina, Bayer process, R&D, Value drivers

Global Review and Update of the Non-Metallurgical Bauxite and Alumina Industries

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Roskill Information Services Ltd., UK

Abstract

The non-metallurgical bauxite and alumina markets are significant industries in their own right, but are often overshadowed on the global stage by the much larger aluminium feedstocks sector. This is despite the fact that the non-metallurgical grades are typically being much more tailored and higher-cost products. These grades find application in numerous different end uses that each have their own supply chains and market drivers.
Non-metallurgical bauxites have tighter specifications than metallurgical grades used in Bayer alumina production, with calcined bauxite grades requiring high alumina levels and low iron and TiO_2 contents. Therefore, calcined bauxite production still requires specific processing steps and added costs that are not applicable to metallurgical bauxite. Demand for calcined bauxite is also driven by a host of markets – from refractories, to proppants and abrasives – that are divorced from the metallurgical bauxite sector.

Calcined aluminas for non-metallurgical applications range from standard grades for use in refractories and ceramics, through to more technical tabular/sintered, sol-gel, reactive, and ultra high-purity aluminas. As product purity and processing complexity of the alumina end-product increases, so too does its price; however, the number of producers capable of manufacturing these grades also decreases.

This presentation will outline significant developments in the non-metallurgical alumina and bauxite sector over the last decade and the major trends affecting the industries. It will also provide an insight into potential growth areas, which could affect future demand.

Evaporative Systems for the Alumina Industry – The Choice

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Abstract

The duty of the evaporative system in an alumina refinery is to concentrate the dilute spent liquor, which leaves the hydrate precipitation in order that it can be recycled to the bauxite digestion stage. This enables the valuable caustic liquor to be recovered and re-utilized.

Although various evaporative techniques can be used their main aim is the removal of water from the spent liquor at minimum cost because the quantities of water that has to be evaporated in

modern refineries are very large. Steam based systems are normally used and to minimise the steam consumption multiple effect evaporators are mandatory.

Today the choice is mainly between **multiple effect falling film evaporators** with typically up to six effects or **multiple effect flash evaporators** with typically up to twelve effects. In the past rising film evaporators were used however compared to falling film evaporators they suffer from a lack of flexibility and have today essentially been replaced by falling film units. For special applications for example where solids are present, such as salting out, forced circulation evaporators are used.

The aim of this paper is to examine the main operating differences between multiple effect falling film evaporation and multiple effect flash evaporation systems and to highlight their advantages and disadvantages with respect to the following criteria:

- liquor concentration factor (ratio between the concentration of the spent liquor feed and the concentrated green liquor product)
- heat transfer area (of the falling film evaporators or flash heating chests)
- steam economy (ratio of total evaporation against steam consumption)
- power consumption (of the pumps)
- scaling tendencies (of the heat transfer surfaces)
- commercial aspects

In particular, it will be shown, that the required liquor concentration factor is significantly influenced by the requirements of the bauxite digestion step and that this has one of the most important influences on the choice of the most suitable evaporative system.

Prospects for Ceramic Proppant in Gujarat, India

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Abstract

The ideal Proppant should possess specific gravity of water, strength of iron and cheaper than dirt. Ceramic Proppants are derived mainly from Calcined Bauxite.
Ceramic Proppants are used in higher closure stress environments invariably deeper reservoirs, can increase well stimulation by up to 30%, they are stronger, more uniformly dense, more spherical, better conductivity, more expensive, high strength, intermediate density, light weight.
Gujarat Bauxite is superior in quality and predominantly, it is Gibbsite nature with high percentage of alumina and less reactive silica. Calcined Bauxite factories are concentrated in Jamnagar and Kutch districts. The State produces 4, 10,000 MTPA calcined bauxite in its ten rotary kiln and 1, 00,000 MT in its VSK cupola plants. It is mostly consumed by high alumina refractory units.
Domestic technology is developed by "North East Institute of Science and Technology, Jorhat, Assam." According to process know-how 12/20, 20/40 size, with 0.7 spheroids and roundness

(***Krumbein and Sloss***) for stated stress level of 10,000 PSI with API specification (RP60) can be produced by paying technology transfer fee of Rs.16 lacks and additional Rs.12 lacks for basic design for commercial plant. Even overseas technology can be availed from ***Currimbaba***, ***Carbo Ceramic*** and ***Saint-Gobain*** after pilot plant production from the specified bauxite pockets.
The entrepreneurs can avail the domestic and overseas process- know-how as Bauxite containing higher alumina, lower silica and calcium is normally advantageous for the product. Above specification, Bauxite pockets occur in Jamnagar and Kutch districts. Recovery of high grade is 12% to 15%, which can be considered for most high value-added, market demand item instead of conventional refractory item.
Approximate mineralogical composition by normative calculation for ***Bhopamandi*** in Jamnagar and ***Ratadia*** in Kutch indicated above specified advantageous pocket.
Detailed mineralogical analysis, with emphasis on calcite can also reveal more potential areas for the item.
In near future, Jamnagar Bauxite deposits will be made open for new auction system, so the bidders can check the analysis of the area for the item and acquire *Prospecting-cum-Mining Lease* for the trial. Even mineral conscious entrepreneurs have tried Calcined Bauxite and Raw Bauxite of Gujarat for Proppant and succeeded in trial production.
The Projects need detailed mineralogical composition by normative calculation to go for commercial project.
Gujarat Oil and Gas reservoirs of Mehsana, Ankleshwar, khambhat Tarapur, and Tapi are deep-seated, so stimulation service of ONGC is always in demand of the product for dead-wells, which is full-filled by imported product.
Considering 49% market share of the product, prospect for the projects are bright and viable in the state.

High Alumina Cement Production and Future Prospectus in India

Gajanan Thakre
Castwel Industries, India

Abstract

High- alumina cements also known as calcium aluminate cement are the speciality cement which are different from Portland cement by its chemical properties and high early strength development. HAC are the main binder used for the manufacturing of refractory castable and hence its demand is increasing as demand of refractory increase. In the first generation of monolithic the HAC were the one and only binding agent used. The high early strength, good corrosion resistance and to withstand at high temperature are the properties of HAC account for its wide use in refractory castables.

The major mineral phases present in HACs are Monocalcium aluminate (CA), Monocalcium dialuminate (CA_2), Dodecacalcium heptaaluminate ($C_{12}A_7$)

Properties of HACs depend on its mineralogical phase composition. Like CA phase is responsible for development of highest strength, $C_{12}A_7$ phase controls the setting time of cement and CA_2

phase imparts good refractoriness. In India mainly there are two types high alumina cement being manufacture and used in monolithic castables. Medium purity cement and high purity cements.

This paper deals with manufacturing process of Medium purity cement and High purity cements, its analysis and marketing avenues.

Experimental Analysis on Flow and Mixing Characteristics of Scale-Down Digester Model

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2. Hindalco Industries Limited, Muri, India

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Abstract

Alumina is extracted from bauxite by double digestion process followed by precipitation of sodium aluminate liquor and calcination of hydrate particles to produce metallurgical grade alumina. The current digester design is equipped with multi-staged agitator and the flow pattern, power consumption and retention time depend not only on the impeller design but also on the tank geometry and internals design. It is imperative to validate the hydrodynamic models against the experimental data to validate the capability of the computational flow dynamics (CFD) model predictions. The pilot scale cold flow model is scaled down geometrically by $1/12^{th}$ of the actual industry scale. The CFD predicted flow pattern, power consumption and retention time distribution (RTD) are validated using ultrasonic velocity profiler (UVP), torque table and conductivity probes respectively. The optimized models along with the experimental validation helps the project team to implement design modifications in alumina refineries with additional confidence.

Key Words: Alumina digester, scale-up, design optimization, impeller, flow, RTD

Numerical Modeling of High Rate Decanter (HRD) Feed-Well

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Abstract

In Bayer alumina process, thickeners are the key unit process that are used to separate solids (Bayer residue particles) and liquid (sodium aluminate solution). The feed well of the thickener basically retards the momentum of the incoming solid-liquid slurry; holds for a while by mixing along with the flocculent to flocculate the incoming solids and finally distributes the flocculated mass to the main decanter body. The current study using three dimensional CFD (computational fluid dynamics) focuses only on the assessment of industry scale feed-well design with respect to flow pattern and the mixing phenomena by varying the slurry throughput. The three dimensional distributions of slurry flow pattern, shear rate intensities and residence time distribution (RTD) are analyzed in the present work. The design investigation for the slurry throughput has provided an important insight for the plant operation and control for industry scale HRD.

Keywords: Bauxite, HRD feed-well, flocculent mixing, RTD, CFD, Dispersion number, E-curve

Ion Exchange's Speciality Chemicals for Mining Solutions

Ajay Popat

Ion Exchange (I) Pvt. Ltd., India

Abstract

The Bayer's process is a unique, complex mineral refining process. Future of alumina refineries relies on product quality, profitability and increase in throughput by adopting new designs, speciality chemicals and better fluid mechanics. IEI mining solutions offer wide range of speciality chemicals and technologies to improve process efficiencies. This paper gives a brief idea about importance of speciality chemicals to improve quality of operations.

Total Water Management and Concept of Zero Liquid Discharge In Alumina Industry

Ajay Popat
Ion Exchange (I) Pvt. Ltd., India

Abstract

Pollution and increased demand have made good quality water scarce and expensive, both in terms of direct cost of water and the effect of unsuitable water on plant economics and product quality. Meanwhile, disposal norms are getting tighter and their enforcement stricter.

Ion Exchange (India) Limited can help you to effectively and economically solve the aluminium industry's water scarcity problems by conserving vast volumes of water and protecting the environment by reducing discharge... while generating substantial savings for the industry.

Best Practices in Red Mud Management at Vedanta

Bimalananda Senapati[1] & C. Sateesh Kumar[2]
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Abstract

The Alumina Industry is countering a plethora of challenges primarily owing to social and environmental reporting, the challenges of sustainable operations, green house emission and developing the image of green industry and competition from substitute materials. It has been realized that such challenges can be best managed by sharing the best practices and by setting up benchmarks for further improvements. The individual Alumina industry can greatly improve in all the areas of plant operations as well as environment, health and safety aspects by sharing experiences, thereby increasing the collective knowledge and avoiding duplication of efforts.

Vedanta has taken challenges towards effective utilization of red mud after implementation of red mud filtration system and undertaken various R&D initiatives, outcome of some of the studies are being presented in this paper which reflects the industry's acknowledgment of the growing impact of environmental and social issues on business practices. Further to achieve goal of zero waste, both continuous improvement through incremental changes as well as significant advances through innovative step changes will be implemented to address the challenges in red mud utilization in the years to come.

Key words: Red mud, filter, disposal, management and utilization

Red Mud Containment: Muri Case Study

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Abstract

The disposal/storage of **red mud** is becoming a challenging issue, due to the high cost associated with the requirement of large area of land and the difficulties associated with its compaction due to high moisture content. In addition, pollution resulting from highly alkaline leachates from the **red mud** and its tendency to get air borne during summers makes its disposal more challenging. In this context, this paper is intended to walk through a case study which was taken up at Hindalco's alumina extraction plant, Muri. A proper containment of red mud became essential at this plant as the Hindalco management decided to augment the storage capacity of the pond designated for disposal of the **red mud**. To achieve this, a special type of flexible retaining wall system, the 'composite reinforcement soil system and gabion retaining wall system' were recommended. Keeping in view the availability of the red mud in abundance, and in order to utilize it as a geomaterial, the red mud was employed as the fill material. 'Gabion gravity wall' was constructed at the bottom of the composite soil reinforcement system to avoid excessive excavation. However, due to poor drainage characteristics of the red mud, special care was taken to ensure proper drainage (dissipation of the pore water pressure). A high performing **drainage geo-composite** which is combination of 'drainage net' and 'two geotextile' layers was employed as the main component of drainage system, which is reported to be performing very well.

Key words: Red mud, Storage, Gabion wall, Geo-composite

Study on Safe Storage of Bauxite Residue at Utkal Alumina

S Bhaurao, Rajesh Khuntia
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Abstract

Red mud is a harmful alkaline waste to the environment gets generated during refining of bauxite to yield alumina. As the percentage of alumina found in bauxite ore is generally between 30-50%, approximately 1 - 2 tons of red mud is generated for every ton of alumina produced. Being harmful and produced in large quantities, red mud poses a huge environmental challenge for disposal.

Conventionally, red mud produced is pumped into clay-lined dams or dykes and allowed to dry naturally. Thus, for the conventional disposal of red mud requires large open land. It causes additional problems especially for refineries with limited land space. With advances in separation technology high density mud is disposed. In modern plants, red mud is filtered (on vacuum / high pressure filters) and dry mud is stacked. It is an expensive and medium term solution, may pose serious problem for long term sustainability.

Over the years, there have been several attempts are made to find alternate use of red mud and still no commercially viable route has been established to process the red mud in proportion to its bulk generation. The most promising and widely tested process is neutralization of red mud and rehabilitation of land.

As part of one more attempt, experiments are carried out for neutralizing the red mud generated in one of the Refineries of Hindalco Industries Limited, situated in Odisha. In the said attempt, series of experiments were conducted by using industry effluent and indigenous resources and found that in some of the experimental runs pH of red mud lowered to the range of 5.73 - 6.38 from an initial value of 11.69.

Mineralogical and Chemical Studies on Uncalcined, Calcined and HCl Treated Red Mud Waste

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2. GM (R&D), NALCO, Nayapalli, Bhubaneswar, Odisha-751013, India

Abstract

In the present study, the mineralogical and chemical characteristics of uncalcined, calcined, and HCl treated red mud waste was examined using XRD (X-ray diffraction) and EDS (energy dispersive spectroscopy). The temperature range considered for calcination in the study was 100°C to 600°C. Analysis of diffractograms indicates decomposition of Gibbsite into Al_2O_3 and H_2O and dissolution/disappearance of goethite at about 300°C. After calcining above 500°C, the calcite mineral was converted into CaO and CO_2. Results of HCl treated red mud waste shows a complete dissolution of Gibbsite and Calcite at pH-1 and pH-3 respectively. Also, formation of Rutile mineral when the pH is lying below 5 was identified.

Keywords: Red mud waste; calcination; mineralogical composition, chemical composition

Extraction of Rare Earth Elements from East Coast Bauxite Residue

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2. General Manager (R&D), NALCO
3. Scientist, NML

Abstract

There is an increasing need for rare earth metals and limited primary sources in India vis-à-vis considerable global market demand. The exploitation of red mud as secondary source for rare earth elements (like La, Ce, Pr, Nd, Sm, Eu, Sc, Y etc) has been claimed. It is difficult to directly recover REE's from red mud due to its low levels and presence of major minerals of Fe, Al, Ti. Separation of REE after extraction is also a concern due to presence of iron, titanium, etc., which usually gets co-extracted. This article elicits a comprehensive review on the presence of REE's in red mud comparing it with Indian scenario, their mineralogical characterization and its association. The paper elaborate the results of first of its kind work on extraction of these rare earth elements from red mud in India following beneficiation, acid leaching processes etc. Although the quantities of REE contained in red mud appear to be low, large quantities of red mud enriched with the series of REE can provide a reserve for secondary source of La, Ce and Sc. The economic viability of REE production from Indian red mud needs careful assessment due to the investment required in mineral processing and extraction technology. Further research needs to be focused on improved characterisation of red mud stockpiles, selective mining of REE enriched bauxites, and the development of efficient REE recovery techniques from red mud to fully assess these potentially important resources.

Keywords: red mud; rare earth elements; leaching; La-Ce-Sc.

Processing of Various Industrial Wastes for the Extraction of Alumina

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Abstract

Recovery of useful materials from different industrial wastes has been the subject matter for past several years. The aluminium industry is no exception in this respect. A lot of research and developmental activities are going on throughout the world to develop technologies for effective utilization of various waste materials such as red mud, fly ash, aluminium dross, etc. which are usually generated by aluminium industries. The present work has been aimed to develop suitable processes for the recovery of alumina from such waste materials.
Red mud is the major waste material produced during alumina production through Bayer's process. Depending on the quality of the raw material processed, 1–1.5 tons of red mud is

generated per ton of alumina production. The treatment and disposal of this residue has been a major concern in most of the alumina plants. A hydrometallurgical process was developed for the extraction of alumina from NALCO red mud, containing about 18-20% Al_2O_3 and 45-50% Fe_2O_3. The red mud was subjected to soda roasting followed by water leaching. Soda roasting was carried out at a temperature of 900 °C for 2 h with a varied red mud to soda ratio. Leaching of the roasted red mud was conducted in water at 90 °C for 2 h with a pulp density of 10%. The extraction efficiency during leaching was found to be about 85.5%. Subsequent to leaching, 96.6% of alumina could be recovered from the alkali leach liquor through pH adjustment by adding dilute sulphuric acid.

Coal fly ash, derived from coal combustion in thermal power plants is one of the most complex and abundant of anthropogenic materials and it is rich in alumina, making it a potential substitute for alumina resources. In the present study, NALCO fly ash containing 24-27% Al_2O_3 was treated through a process comprising of partial desilication through sodium hydroxide leaching followed by precipitation of calcium silicate, sulphation roasting of the partially desilicated residue and then solubilisation of aluminium through water leaching of the roasted residue, separation of iron from the sulphate liquor through precipitation of iron hydroxide, precipitation of aluminium hydroxide from iron free sodium aluminate liquor and production of alumina by calcination of the precipitated aluminium hydroxide. Alumina of 99.5% purity was produced from the fly ash using this route with an overall recovery of about 85%. Fly ash was also processed through another route involving hydrofluorosilicic acid leaching followed by precipitation of aluminium fluoride (AlF_3). The hydrofluorosilicic acid leaching efficiency was more than 95% and the optimum precipitation efficiency for AlF_3 was found to be 60% only.
Processing of aluminium dross is one of the most challenging tasks because of its toxic nature. In the present work, aluminium dross containing about 65% Al_2O_3 and 5-6% Al was processed through soda roasting followed by dilute NaOH leaching to extract alumina values. The dross sample was roasted at a temperature of 800 °C and then leached in 3% (w/w) NaOH solution to solubilise alumina. The leach liquor was then subjected to carbonisation for the precipitation of aluminium hydroxide. Calcination of the aluminium hydroxide precipitates at 1200 °C produced α-Al_2O_3 of 99.6% purity. The overall recovery of alumina from dross was found to be more than 90%.

Shenwu's Innovative Process for Comprehensive Utilization of Bauxite Residue (Red Mud)

Cai Suning
International Business Development,
Beijing Shenwu Environment & Energy Technology Corp., China

Statistics show that over 95% of the alumina produced globally is derived from bauxite by the Bayer process. Bauxite residue is one of the large industrial by-products from this process and the amount of bauxite residue produced by an alumina plant or refinery can vary from 0.3 to as high as 2.5 tonnes for per tonne of alumina produced.
China contributes to this figure with annual generation of around 30 million tonnes, and the total accumulation is more than 200 million tonnes. Without proper treatment, red mud will cause

more environmental and social problems on the one side, and a great waste of resources on the other.
Current treatment practices of red mud include ponding, seawater discharge, mud/dry stacking, landfilling or road construction, or use as additives in cement manufacturing. Considerable amounts of Fe in the form of Fe_2O_3 (20-45% or even up to 58%) or other valuable elements like zinc contained in red mud are normally not properly utilised in those practices.
Beijing Shenwu Environment & Energy Technology Corp. (Shenwu Group) is a solution provider for energy conservation and environmental protection technology targeting at global fossil resources, and atmospheric haze control technology. With Shenwu's RHF technology for Iron Recovery + gas smelting coupled with the already established downstream process of rock wool and ceramic fiber making, not only such elements can be extracted on a large scale from red mud in the form of iron briquettes or pig iron (>95% Fe) for a better utilisation in the steel making sector, but also value-added products like rock wool and ceramic fiber can be made from the remaining smelting slag.

The iron recovery part of the red mud utilisation process flow is Shenwu's coal-based direct reduction process via a rotary hearth furnace (RHF). Red mud first is mixed with reducing agent like pulverised coal and additives (used as flux). These materials are then agglomerated into green pellets or briquetted, before being dried and charged into an RHF, a reduction reactor, where the agglomerates will go through preheating, reduction and cooling zones, in which iron oxide contained therein is reduced from its oxide form (Fe_2O_3 or FeO) into metallised Fe to be hot discharged as DRI.

Since other impurities of high percentage are physically bound with the metallised Fe in this kind of DRI, the same have to be separated from metallised Fe and have to be dealt with in order to achieve zero-waste discharge. A downstream gas smelting process has been developed at Shenwu to facilitate the comprehensive utilisation of these metallurgical wastes.

In the gas smelting process, developed in-house at Shenwu, the hot DRI discharged from RHF is directly loaded into an iron bath where the DRI is melted and metallised Fe is tapped from the iron bath in the form of hot metal (more than 95% Fe). In this way, the impurities are separated in the form of slag. The hot slag however, is then loaded into an EAF, where it is heated up to 1500°C before being fed into a conventional thrashing machine for rock wool making.
Results from both basic tests and pilot plant tests carried out at Shenwu's lab show an average of >93%-97% Fe content in the hot metal recovered from the red mud from different sources, with an average iron recovery rate of >90%.

The hot metal can be made into pig iron, a quality product for steel making, and the slag can be made into rock wool or ceramic fiber, also a high value-added product. With this innovative process, comprehensive utilisation of red mud and conversion from waste-to-wealth can be effectively realised for both better environmental and economic benefits.

A project adopting this process flow for comprehensive utilisation of red mud is intensively under way at Chinalco's Shandong Branch in Zibo City, Shandong Province, China. Treatment capacity of the red mud (having an Fe content of <30%) for this Chinalco project is 300,000TPA, and construction period of this project will be one and half (1.5) years.Upon completion, the plant will have an iron production of 52,800TPA and a rock wool production of 117,000TPA. The iron recovery rate of the red mud will be 91.36%, after repeated tests for a sound verification of the

process flow at Shenwu's world-class laboratory for Energy-Saving & Low-Carbon Technologies/Natural Resources Upgrading.

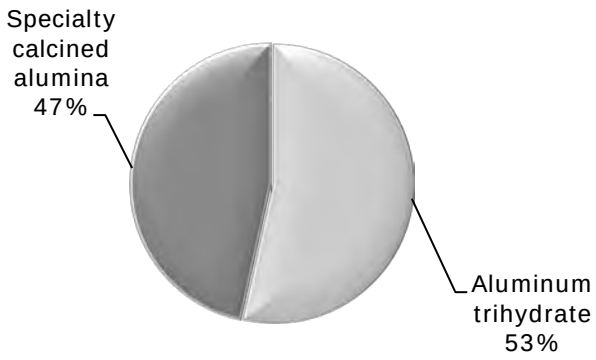
Aluminium Chemicals Market – Focus on Water Treatment Chemicals and Fire Retardants

Samantha Wietlisbach
IHS Markit

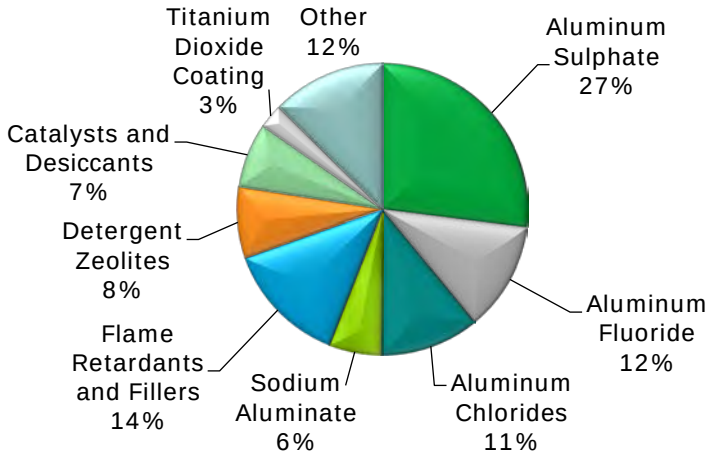
Abstract

Non-metallurgical alumina accounts for 6% of global alumina consumption, and just over half can be classified as chemical grade alumina trihydrate (ATH). This material is consumed to produce aluminium chemicals, including sulphates and chlorides. Fire retardants, detergent zeolites, catalysts and desiccants, are important direct uses of chemical ATH

Global demand for non-metallurgical alumina (6.6 Mt) in 2015



Global demand for chemical grade ATH (3.5 Mt) in 2015



ATH is the most commonly used flame retardant filler in the world, accounting for about 36% of the total global flame retardant demand in 2015. It is cheap, effective and breaks down to low toxicity components in a fire. It can be used in many different products, including plastic cable covers, roof tiles and sealants. We will look into its action, compared to other flame retardants, look at the market size globally and discuss the forecast market growth by region over the next few years.

Aluminium sulphate is a very effective coagulant in water treatment. The market size for the various water treatment chemicals will be discussed and the benefits of the available aluminium chemicals versus the main competing chemicals, including ferric chloride.

In Western European aluminium chlorides are used in municipal and industrial water treatment and pulp and paper production. The overall growth forecast will be discussed, looking at the main end use applications.

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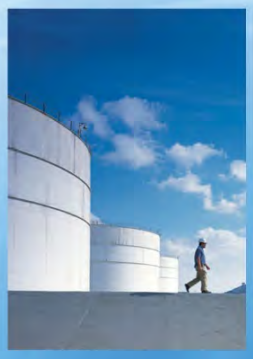

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SECTION – II
ABSTRACTS

ALUMINIUM – SMELTING

Indian Aluminium Industry - Challenges and Opportunities

Abhijit Pati
CEO, Aluminium Business, Vedanta Limited, India

Abstract

India currently boasts 3.2 billion tonnes of bauxite reserves out of the 77 billion tonnes of reserve available, which accounts to almost 5% of the entirety. In India, the Growing aluminium market and a supply gap to cater to, the domestic players are encouraged to opt for volume expansion and in an attempt to gain market share, also improve their product mix. Applications of Aluminium is venturing into new avenues coupled with technical breakthroughs to help bring down the Cost of production, is the silver lining to this particular industry. The Global Aluminium industry has been through a precarious position and is showing quasi improvements over the past couple of months. The market demand and dynamics has landed us in a rather favorable position, where there is a surge in domestic market. The world growth stands at 4.7%, India is well positioned in the top quartile with a growth rate of 7.7%.

This opportunity comes at the backdrop of the projections made by the IMF, which features India as the prime destination for investments and major developments. Projected growth rate of India is at 7.4%, 0.1% down due to Brexit.

India has all the resources to become a world leader in producing cost efficient and quality of the highest order, provided it utilizes on the wealth of natural resources that comes as a natural endowment.

Aluminium metal will play a very vital role in 'make in India' campaign and also in developing smart cities. Indian Primary aluminium producers have both challenges and opportunities to sustain and grow in this volatile market environment. The main mantra is to reduce the input costs of raw material & energy cost. Raw material sourcing and captive mining with government's support can take the industry to a different height coupled with higher GDP growth of our country. With advent of new cutting edge technologies, smelters are now in a better position to upgrade the existing vintage smelters and bring down energy consumption to below 12,000 Units/Mt. New technologies can improve pot productivity and reduce energy consumption and GHG emission, this will not only help reduce the cost in the long run but also will benefit to reduce carbon foot print.

RECENT ENERGY REDUCTION INITIATIVES AT HINDALCO

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Hindalco Industries Ltd., Mumbai

Abstract

The growth story of primary aluminium smelters in India has not been as dramatic and rapid as in case of other industries, even in the post reforms period. This despite the fact that India is blessed with the fifth largest high grade bauxite deposits, and a large captive market for the aluminium produced. In case of Steel, India is currently among the top 3 producers world-wide, whereas for aluminium we are the 8th largest producer.

Access/availability of steady power supply has been the single biggest challenge facing the aluminium smelting industry in India. Worldwide aluminium producers installed smelters close to hydro-electric power stations. (Russia, Canada, Europe) The steady base load power requirement of an aluminium smelter ensured that these hydroelectric power plants operated at optimum efficiency, and it was a symbiotic relationship between the 2 industries, since the end product aluminium served primarily for electrical conductors to transmit power.

Hindalco also installed its first smelter at Renukoot adjacent to Rihand dam in Uttar Pradesh. However with erratic power supply from the dam, our late Chairman, decided to build a coal fired power plant based on coal from nearby coal mines. The decision to install captive coal fired power plant at Renusagar was a turning point in history, and thereafter we see all large aluminium smelters installing captive power plants to ensure steady power for its smelters in India and in other parts of the world.

Our Aluminium smelters have made significant improvements as seen from table below

	Early 25kA	**Hkd/Rkt**	**Aditya/Mahan**
Line Current-kA	25	70-85	360 - 370
DC kWh/t	17000	14300	13300
Current Efficiency	86-88%	93-94%	94-95%
Anode effect	1.2	0.1- 0.2	<0.1
Anode Carbon	560	430	415
AlF_3	35	18-20	15-16
AC-DC losses	3%	2%	1.7%
Metal purity (Al)	99.5%	99.7%	99.8%

Recent initiatives taken by Hindalco at its smelters to reduce specific energy consumption

1. Modify/fine-tune control logic in pot controllers to achieve lower anode effect frequency and GHG emissions
2. Successful use of LBD AlF_3 in high amperage pots through point feeder
3. From a bath deficit to a bath surplus organisation
4. Innovations in use of new lining design and materials to reduce cathodic drop
5. Anode cover using bath-alumina mix, to reduce heat losses and anode air burn
6. Training and skill up gradation of smelter professionals
7. Ensure shop floor discipline and adherence to SOP
8. New anode baking furnaces with modified anode design and quality

Hindalco has had successful tie-up with technological companies (RTA, AP, GAMI and Riedhammer) across the world. All these tie-ups have yielded successful results across our 4 smelters. One of the key priorities is now to ensure that knowledge and experience is shared across our plants.

Power stability has been a key challenge for Indian smelters, since all smelters are connected /synchronized with the respective state power grid. It is difficult to sustain a smelter with zero power beyond 4 hours. To minimise power interruptions, black outs, following additional innovations have been done at our units –

1. Installing an emergency DG unit to restart the boiler feed pump, auxiliaries in the event of blackout
2. Install grid islanding system and software, wherein the smelter and power plant electrical system is islanded(isolated) from the state grid in case of a drop in frequency or any other grid disturbances
3. Introduce partial feeding of power /control logic to keep pot line warm and operative during period of lower power availability.
4. Modify process control parameters like metal height, bath ratio.

Hindalco having recently commissioned 2 large Greenfield smelters at Aditya and Mahan will now strive to make these 2 smelters among the most energy efficient smelters in the world, through a range of energy conservation measures being identified. It is also launched a parallel set of energy conservation projects at its older smelters to make the energy consumption levels on par with the new smelters.

Energy Reduction in Aluminium Smelting

Halvor Kvande
Professor Emeritus, Norwegian University of Science and Technology (NTNU), Norway

Abstract

Aluminium is the most energy intensive of the major commodity metals, and the strategy of the primary aluminium industry has always been driven by the search for cheap electric power. With the global demand for energy increasing steadily and also with rising energy cost, energy savings in all parts of the production process will continue to be an important task for aluminium smelters also in the coming years. The traditional view for minimising energy consumption for a given line current has been based on two main parameters, cell voltage and current efficiency. Cell voltage is directly proportional to energy consumption, while current efficiency is inversely proportional. Cell voltage reduction implies anode-cathode distance (ACD) minimisation. However, energy is required to maintain the electrolyte at target temperature and superheat. So in most cell lines now there is little flexibility for lowering the total cell voltage without improved work practices and/or cell design changes. We can reduce the negative impact of work practices on energy consumption, particularly regarding anode change, which is a major root cause of poor cell operational performance. The focus should also be on cell design changing technologies in order to improve the energy efficiency. On this basis the present paper will review and discuss key issues for reducing the energy consumption in aluminium electrolysis cells.

Keywords: Aluminium, Hall-Héroult cells, Energy consumption (DC kWh/kg Al), Energy efficiency (%), Recycling

Improvement Effect Analysis for Long-Term Management Optimization to Electrolysis Production Parameter

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Abstract

Although the technical level and operation requirements for increasing the anode change operation quality, improving the anode cover material ingredients and enhancing the supervision of key process parameters are not high, they are usually ignored by management and executive staff. The practices and data analysis of long-term test show that: if the above-mentioned operations and management is optimized and stuck to for a long term, so as to make the operation basis of electrolysis production to form the good habits and standards, also the better energy-saving & cost-reducing benefit still can be obtained.

Keywords: **Tapping current efficiency; Feeding Current efficiency; Stability parameters**

The Cathode Materials Wear Rate in Aluminium Electrolysis - A Laboratory Studies

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Abstract

Paper concerns the research of the cathode wear by determining the wear rate as function of experimental operating parameters during aluminium electrolysis in the laboratory cell, and to see if it was possible to rank different types of cathode materials with respect to the wear rate.
The principle of the method is based on the use of an inert anode (tin oxide) in a cell where the only source of carbon is the cathode test material kept at the bottom of the cell beneath the electrolyte and the layer of aluminium. By determining the gas flow rate and the CO and CO_2 content in the outlet gas at steady state the carbon flux can be found by mass balance. In the laboratory set-up the time needed to reach steady state condition was at least three hours after the start of electrolysis.
Three different types of cathodic materials were studied. The idea was to expose these two different current densities, since the current density was assumed to be one of the most important variables in the cathode wear mechanism. The current densities have been varied by keeping the current constant and varying the exposed cathode area.

Keywords: aluminium electrolysis, cathode wear

Cathode and Modelling Solutions – Implementation of Low Energy Consumption Relining Electrolysis Cell Design at Bharat Aluminium Company (BALCO)

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2. SGL CFL CE GmbH, Meitingen, Germany
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Abstract

Bharat Aluminium Company (BALCO) is 51% owned by Vedanta Limited and 49% by the Government of India. Primary Aluminium smelter is located in Korba city, Chhattisgarh State. Plant 2 has been in operation since 2006, using technology from Chinese company Guiyang Aluminium-Magnesium Design Research Institute Co. Ltd (GAMI). There are 288 electrolysis cells installed, GP320 prebake cells operating at 325kA.

SGL CFL CE GmbH (SGL) is part of SGL Group, the Carbon Company, one of the largest carbon and graphite manufacturing companies in the world with 42 plants worldwide and Headquarters in Wiesbaden, Germany. SGL is supplying cathode blocks, side wall blocks and ramming pastes to many of the primary aluminium smelters throughout the world. SGL products are installed in all the primary aluminium smelters in India.
In 2013, BALCO and SGL established an Energy Reduction project for primary aluminium electrolysis cells installed in BALCO Plant 2. Project objective was to reduce energy consumption by 15% reduction in Cathode Voltage Drop (CVD). This was to be achieved by redesign of electrolysis cell using modelling study by SGL and migration from amorphous to graphitized cathode blocks manufactured by SGL.

This paper will describe: methodology used for data collection; modelling study carried out at SGL and proposed cell redesign; operation of cells over 2-year period and validation of the modelling. Energy reduction objective has been satisfied and progress to full scale production is underway.

Not All Aluminium is Created Equal

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Abstract

Major Indian aluminium producers have increased their production significantly in the recent past. Yet capacity is under-utilised. About 40-50% of the metal produced is exported; domestic demand needs this metal.
Indian economy is taking off impressively. Indian aluminium usage growth rate is the highest in the world. Aluminium is one of the backbones of a modern economy as it is required in infrastructure, transport, construction and high-tech sectors and its usage within these industries itself is swelling. India's exciting economic progress will result in huge demand increases in aluminium.
Further capacity additions to meet demand will require enormous capital investment and will have long lead times. Raw materials and energy will continue to be serious impediments. Considering the large aluminium stocks in warehouses around the world, expanding domestic capacity would be a questionable rationale.
Increased importation is the most likely answer in order to feed economic growth. Imports will also offer a major advantage to India's economic growth as it "frees up" energy for other industrial activity. Different aluminium producers have different carbon footprint and other attributes; where best to import from, as 'not all aluminium is created equal'?
India is ideally suited to value-adding manufacturing business and hence ought to take to downstream manufacturing in a big way. India could sell finished products to the world after satisfying the domestic market.

Initiatives for Improving Energy Efficiency in Aluminium Smelting Pots

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Abstract

The aluminum industry is experiencing a severe crisis since few years, including a sharp decline in commodity prices which is impacting the profitability and margins of aluminium smelters. Although aluminium is the most abundant metal element in the Earth's crust, but it rarely occurs in its native state and the extraction of aluminium relies on complex processes and requires a lot of energy. Primary aluminium production is a highly energy-intensive where 35 ~ 38 % of the total cost of production is contributed by energy cost.

At Vedanta Smelter, as a part of energy reduction program various initiatives were taken over past few years. Team has worked not only in the direction of process optimization but also technical initiatives related to cell design parameters and material selection.

The major driver of energy consumption in an electrolytic cell is pot operational voltage. The typical five components of cell voltage are external voltage drop, cathode voltage drop, anode drop, bubble induced voltage drop and electrolysis voltage drop. With a concept of first time right, a dedicated SOP audit system was introduced and critical parameter tracking and review mechanism was introduced for the reduction of process standard deviation, which contributed in reduction of bath drop. Energy efficient lining materials were used in cell lining to reduce cathode voltage drop. A major part of the input voltage to the pot is lost in terms of heat dissipation. To tap this potential team has worked on small modifications in refractory lining, material quality and external insulation, resulting in optimized heat balance giving an opportunity for further reduction of cell voltage.

Startup power is another significant contributor to the power consumption of any aluminium smelter. To reduce startup power consumption trials were taken with special anodes for pot startup, which has started showing positive results.

These energy saving initiates along with continuous process improvements have great potential of reducing energy consumption in aluminium smelting pots which were realized by Vedanta Limited resulting in energy reduction of more than 800 units of specific power consumption in last few years.
The paper highlights about major initiatives taken in-house to optimize pot operating voltage and improve process parameters by strengthening internal audit mechanism.

Energy Management through Implementation of ISO: 50001 in Vedanta Aluminium Smelter

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Abstract

Aluminium smelting process is energy intensive & sensitive also. One kg of aluminium production requires around 13.5 units of DC energy for electrolysis. DC energy contributes 95% of total energy consumption in a smelter. Energy is a major cost driver for any aluminium smelter as energy cost is almost around 35 ~ 38% of total COP of hot metal. Hence to achieve sustainable performance and growth, the energy performance of a smelter plays a vital role.

Vedanta Smelter Plant, Jharsuguda strengthened its effort for energy management and energy cost reduction through implementation of ISO: 50001, internal and external energy audits, Business Excellence model & Asset Optimization (AO+) frame work. There is a constant endeavor to improve energy performance by following PDCA approach.

To establish and maintain a superior Energy Management System, employees' involvement is of paramount importance. For building a strong culture of energy conservation we have not only taken care of energy efficiency, but also taken care of employee awareness on energy management both for direct and indirect employees. The paper describes many initiatives taken up based on PDCA concept and ISO: 50001 requirements which include modification of SOPs/ SMP, IT enablement, strong measurement & monitoring system and a culture of innovative ideas implementation.

Technology Roadmap of New Generation Aluminum Reduction Cell Multivariate Process Parameters Intelligence Control System

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Abstract

This paper introduces the new generation aluminum reduction cell control technology, i.e. "Multivariate Process Parameters Intelligence Control (MPPIC)" technology, developed by China Aluminum International Engineering Co. Guiyang Aluminum Magnesium Design and Research Institute Co. Ltd. (CHALIECO GAMI). It focuses on the energy-saving effects achieved by "MPPIC" system's alumina concentration control, cell voltage control, aluminum fluoride control, tapping quantity control and cavity control. The application of this technology in several Chinese smelters and Indian Vedanta Jharsuguda 325kA smelter indicates that the "MPPIC" system can

effectively build a well-structured cavity, improve cell stability, reduce cell voltage as well as increase the current efficiency, and therefore can achieve substantially energy-saving effect.

Key words: Aluminum Reduction Cell; "MPPIC" system; energy saving technology; roadmap; application

Reduction in Carbon Footprint by Implementing Energy Efficiency Improvement Initiatives

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Abstract

Reduction in the carbon footprint is the need of the hour for the continuous and sustainable growth and development. The effect becomes much more prominent when it comes to aluminium smelting, process being highly energy intensive.
At carbon plant, the team took the challenge of transformation by way of in-house technological induction on a continuous basis by implementing the best operating practices.

This paper describes the various improvement initiatives done since inception for the overall improvement in anode quality, cost, productivity and SHE by way of in house technological intervention, reverse engineering, debottlenecking. The paper also deals with the people development and the sustenance by the deployment of the Asset Optimization framework.
The series of these initiatives could lead the carbon plant to achieve a major breakthrough by being the most effective energy efficient plant. This is the only aluminium smelter plant in Asia to achieve the coveted ISO 50001 certification. The plant also declared as the most energy efficient unit with India.

Busbar Refix Method of Aluminum Reduction Cell and Electromagnetic Analysis

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Abstract

Technology of busbar refix for relining reduction cells is introduced in this paper: current shunting and magnetic compensation methods are applied, with supporting ways to open or close corresponding short-circuit ports to reduce the magnetic fields at target positions. With this technology, the difficult problem of fused busbar refix under power off can be solved, as well as the stable running of reduction cells is ensured.

Keywords: Magnetic induction intensity reduction; Shunting & magnetic compensation device; Relining pot; Busbar refix

Reduction of Specific Heavy Furnace Oil Consumption in Baking Furnace

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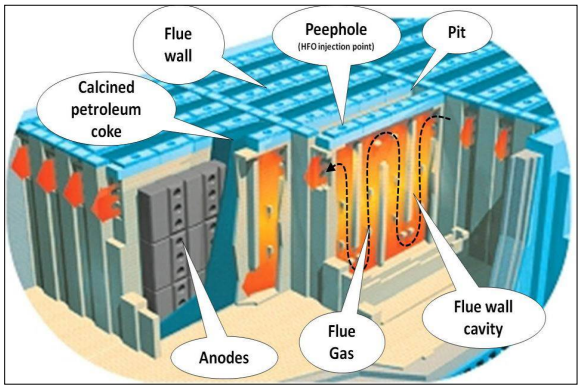
Abstract

In prebaked aluminium technology the anodes are made from a mixture of petroleum coke aggregate, coal tar pitch binder, butts and green scraps moulded into blocks in "Green anode plant" and baked in "**Bake Oven**" at about 1100±10 °C. In the baking furnace, the Green Anodes are baked in a high temperature to increase mechanical strength, decrease electrical resistance & chemical reactivity for effective consumption in the pot room. Baking Furnace is mainly made of fire clay (alumina-silica) refractory bricks. Flue gases are passes through the cavity of flue walls to heat the anodes by conduction. Flue gasses are generated due to the combustion of Heavy furnace oil (HFO), which is injected inside flue walls through injectors.
The Specific HFO consumption is a key element of an anode baking furnace as it has a major impact on the operating cost of a baking furnace. Reduction in Specific HFO consumption will also leads to the conservation of natural resources.

In our work, we identified the causes which lead to higher specific HFO consumption. Elimination & optimization of these causes resulted in a significant reduction of specific energy consumption as well as the operating cost of a baking furnace.



SPL Utilization in Cement & Steel Industry

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Abstract

The Aluminium reduction Cell or "Pot" contains a lining of Refractory Carbon blocks & bricks that contain Molten Cryolite and metal pool in around 960 degree Centigrade temperature. During pot under production ageing causes worn off lining material along with impregnation with chemical compounds.Once the refractory & carbon reaches to end of life, pot is taken out from Production & lining material is removed as **Spent Pot liner**. Other than disposal in a landfill recycling of SPL in cement kiln is today the most widely used option by aluminium producers worldwide.

SPL a national Challenge & being hazardous waste should be looked through holistic view rather as a business opportunity to make money. There are several aspects to consider in determining the cost of treating SPL or its derivatives in cement or Steel industries. In Indian context, with new thought coming in advocacy that SPL material having good calorific value must be used for the saving of natural resources to avoid its fast depletion rather wasting its calorific value because of landfilling.
This paper highlights possibility and methods of co-processing of SPL in Cement and Steel furnaces as a long term sustainable solution. This will increase use of alternate fuels in Cement Manufacturing, thereby reducing

SPL or its derivatives can be introduced into a cement kiln via either of the following.

- Injected as a powder alongside pulverized coal via the kiln burner (first cut SPL only)
- Injected pneumatically into the pre-heater end of the kiln (both first and second cut SPL). This would reduce use of direct fuels by upto 10%.

Impact of Cathode Lining Design on Aluminium Reduction Cell Performance

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Abstract

Increasing energy prices are the key driving force for aluminium smelters to focus on reducing the energy consumption. Last decade, several interesting concepts on cathode lining design particularly cathode design and collector bars, have been reported for energy reduction in aluminium smelters. HINDALCO-Hirakud smelter, over the last few years, has also been focused on reducing the energy consumption in their 85kA end-to-end cells through improved cathode lining design. Design and material modifications of cathode and collector barhave impact on current distribution in the metal region, thereby affecting the cell stability. Computational models provide good insight of electrical, thermal and fluid dynamics inside an aluminium reduction cell, also it is helpful in evaluating various potential solutions. In this paper, computational analysis for cathode lining design modification of Hirakud 85 kA cell will be presented along with the impact of such modification on the cell performance.

Keywords: cell lining, cathode design, collector bars, copper insert collector bars, energy consumption, thermal balance.

Futuristic, Innovative, Energy-efficient Technologies in Aluminium Smelting

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Abstract

Energy saving during the aluminium smelting process is a goal of R&D in the aluminium industry. The theoretical minimum amount of energy required in smelting process is around ~6 kWh/kg of Al while the current practice value is about 13 kWh/kg of Al. To date, improvements to the productivity of the Hall-Héroult cell have been elusive mainly because of design limitations that result from a lack of suitable materials that could serve as an inert anode, especially if combined

with a wettable cathode. Innovations around the development of new processes for aluminium smelting are generally driven by one of three major factors: reduction in energy demand; reduction in capital and production costs, and environmental issues such as greenhouse gas emissions.
The recent trend is towards high amperage technologies (~600 kA) that are less energy efficient but more cost efficient, which is not very promising due to low LME prices of aluminium. Current efficiencies achieved using new technologies are around 96%, while even retrofitting has led to efficiencies around 94 % and above. The challenges are to make technology more energy efficient by lowering cell voltages while maintaining adequate superheat to avoid sludge formation and electrolyte-concentration gradients. These challenges can probably be met through innovative technologies leading to a more energy-efficient aluminium reduction process.

Use of High Sulphur Coke at Hindalco Renukoot Carbon Plant

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Abstract

Hindalco Industries Ltd, a flagship company of Aditya Birla Group is a metals and mining major with Aluminum and Copper Business in India and abroad. Hindalco, Renukoot is located in Sonebhadra district of Uttar Pradesh, India.

A typical carbon plant consists of three units: Paste Plant, Baking Furnace and Rodding Room. For making green anodes in paste plant, the key raw materials are generally calcined petroleum coke, spent anode from smelter and High softening pitch (acts as a binder). Low sulphur CP Coke, in which Sulphur and other metallic impurities are lower, has been in use traditionally for decades due to its availability at the vicinity of Renukoot. Also the size and the bulk density of the low sulphur coke are specified as per our plant design in order to achieve the desired green anode density. Due to the meltdown of LME prices, competition in the market as well as availability of low sulphur coke, sustenance of carbon plant with the usage of low sulphur coke became a challenge for Renukoot carbon plant.

This paper tells us the way to optimize the use of high sulphur coke with respect to its Low BD, extra fines and high foreign material content. Rather, looking at the scenario for the availability and cost of low sulphur coke, this optimization not only reduced the cost of production, either it gave us an option to have different sources and quality of calcined petroleum coke thus eliminating the risk of rising raw material prices in the aluminium industry.

JNARDDC's Journey on the Path of Enhancement in Energy Conservation in Aluminium Sector

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Abstract

Primary aluminium production specially the aluminium electrolysis process to make aluminium from alumina relies entirely on electrical power. Electrical energy costs contribute to a sizeable proportion of primary aluminium production expenses. Aluminium reduction process is extremely complex, which involves complex geometries, variable physical properties, transient behaviour, multiple transport processes, chemical and electrochemical reactions, as well as complex phase equilibrium. Even with the large reduction in energy intensity, the industry consumes nearly three times the theoretical energy required. Significant opportunities for further energy improvements still remain. JNARDDC is constantly making efforts by the way of various in-house and funded projects in the related fields targeting the energy issues. This paper presents some of the primary research projects carried out at JNARDDC.

Key words: Aluminium electrolysis, Energy consumption, electrochemical reactions

Effect of Potassium Salt on Aluminium Electrolyte Liquidus Temperature

Chen Shiyue, Kang Zihua, Luo Xianqing, Cao Bin

Abstract

According to the feature of rich potassium in aluminum electrolyte system, the effect of potassium salt on electrolyte liquidus is studied in this paper. The average reduction amplitude of liquidus is defined to describe the influence of impurities on electrolyte liquidus. The electrolyte liquidus decreases by 0.97-4.50°C by addition of 1% KF. For the electrolyte system with cryolite ratio of 2.2 and 2.3, the effect of reducing electrolyte liquidus by potassium salt is enhanced by lithium salt. The effect of potassium salt of electrolyte system in aluminum electrolysis cells on electrolysis temperature is also discussed based on experimental researches.

Key words: Aluminum electrolyte system; Potassium salt; Liquidus temperature

Discussion on Life of Large Aluminum Electrolysis Cell Influenced by Energy Saving

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Abstract

As the development of energy saving technology in large aluminum reduction cells, the early damage phenomenon of electrolytic cells is becoming the focus of smelters. Reasons for cell life decrease are found out, and corresponding improvement measures are recommended in this paper, based on the comprehensive analysis on reasons for cell life change, cell lining design, selection of lining materials, and cell structure etc.

Key words：cell life, cell lining, cell

Improving Energy Efficiency in Supply Chain in Aluminium Industry

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Abstract

Aluminium has its own benefits in terms of being light, corrosion resistive, conductive and recyclable. Aluminium sector has a significant importance in the growth of Indian economy since the aluminium consumption follows GDP growth curve and also provides employment to masses. Indian aluminium sector is observed as one of the energy intensive sectors with ample scope for improvements in energy efficiency as compared to world standards. Balco has initiated a journey to be pioneer in energy management by Technology upgradation and optimization in existing system. It was found that for production 1 MT of Aluminium requires logistics of 20MT of cargo.

To reduce and optimize energy consumed in this logistics, Balco has taken the following Encon initiatives –

- increase in carrying capacity of BTAP wagons by 11% leading to lower BTAP rake movement
- improvement in bauxite mining quality leading reduction in quantity of bauxite transported
- increase in use of domestic coal and that to from close by mines
- use of higher capacity trucks
- use of higher capacity ladles
- use of fuel efficient engines for technological vehicles
- use of GPS for logistics optimization
- door to door delivery of store issue materials
- use of container rakes to move finished goods.

All these initiatives have helped to reduce 3200GJ/month of energy.

This document is an analytical research on available data on initiatives taken at Balco to reduce energy consumption through supply chain optimization, and to recommend horizontal deployment across Aluminium industry for energy optimization, so that this industry enhances National Sustainability.


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SECTION – III
ABSTRACTS

ALUMINIUM – DOWNSTREAM

Overview of Furnace Aspects of Recycling of Aluminum

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Andritz Metals, USA

Abstract

The paper focuses on the efforts the secondary aluminum industry are making towards recycling aluminum in a "Green" way by saving 170 million tons of Greenhouse (GHG) from being released to the atmosphere by recycling aluminum. Two forms of recycling; in-process scrap and market scrap are discussed together with how furnace equipment is adapted to treat the different requirements of the two recycling streams. Energy conservation drives the industry but productivity improvements and means to improve metal yield also need to be added to the "green" accomplishments of this segment of our industry.

Energy saving opportunities in Aluminium Industry

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Abstract

The author has worked in much aluminium major Cast Houses in 3 countries. He has seen that every **Cast House** offers some good points to learn and unfortunately, has some improvement areas. It is surprising that due to lack of knowledge, common sense and proper planning how energy is lost, quality and productivity are compromised.

All over the world, especially in aluminium industry, huge amount of money is wasted due to energy waste. The author here, with his global experience, has listed down about **opportunities in energy saving in aluminium Cast Houses**.

Energy is being lost

- Poor design and layout
- Poor infrastructure
- Poor maintenance
- Poor productivity
- Poor quality
- Poor SOP
- Poor and untrained operation

With proper understanding of the basics and implementing them we can achieve the most energy efficient aluminium Cast houses. This paper elaborates the above points and the author is ready to help aluminium companies to achieve the objectives.
If all the suggestions are implemented, then fuel consumption in Re-melts (100% solid scrap) and Smelter- Cast Houses (20% solid scrap) would be 60 and 0 lit/ ton respectively.

Cast House Productivity Improvement through TQM Initiatives

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Abstract

Total quality management (TQM) is a general philosophy of gradually improving the operations of a business through the application of rigorous process analysis by every involved employee and business partner. At Vedanta Casthouse, the TQM drive has started 2012 and has shown great improvement in Productivity and Cost reduction which is very crucial at this Aluminium Market scenario. 100% direct employees and almost 92% indirect employees including associate partners have participated actively in various initiatives such Kaizen, QC/LQC and Six Sigma through a structured training & implementation process. Major improvements at Casthouse include increasing Graphite Ring life in Billet casting, Belt life in Wire rod Mill, Reducing Alloy ingot cycle time, Reducing Billet Cutting Cycle time, Reducing Billet Rejection, Reducing Packing cost, Reducing Raw material consumption, Pump house Automation. All the above initiatives have increased Cast house productivity by reducing 1% rejection at Wire rod & Billet, doubled alloy ingot production and finally reduced Cast metal COP by INR 600/MT ($9/MT) in short period. Team have participated in various Internal & State Forums and got recognitions which has further increased the morale of the employees and has brought laurel to the Organisation. The paper highlights the key TQM initiatives undertaken by the team to enhance productivity.

Development of Super Thermal Resistant Al-Zr Alloy for Overhead Transmission Lines

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Abstract

Traditionally Aluminium Conductors Steel Reinforced (ACSR) is used in transmission lines which are characterized by their low permissible work temperature (~80°C). New generation high-temperature low-sag (HTLS) type conductors permit high working temperature (150 – 240°C) thereby enabling more current carrying capacity. JNARDDC is working on the development of super thermal aluminium alloys (STAL) required for manufacture of HTLS conductor cables with special emphasis on reduction of heat treatment time. In the present work EC grade primary aluminium (0.07%Si & 0.14%Fe) is being used to produce Al-Zr conductor alloy (STAL). In order to simulate the industrial wire rods casting, water cooled Cu-Cr-Zr linear mold is used. Cast bars with varying Zr concentration (from 0.1-0.30%) were produced and subjected to heat treatment process (300-550°C) followed by characterisation of electrical & mechanical properties. An industrial trial of Al-0.25%Zr alloy was conducted to produce wire rods of 9.5mm diameter. Various combinations of thermo mechanical treatments are attempted in view of reducing the heat treatment time while achieving the designated properties as per IE62004 specifications. Heat treated wire rods have been drawn in to wires of different diameters from 2.5-4.25mm and properties measured. Results are encouraging where electrical conductivity is improved significantly (~60%IACS) within 48 hrs while achieving 160MPa strength in the drawn wire. Present paper gives an insight of the conductor development work being carried out at JNARDDC.

Energy Efficient Conductors

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Hind Aluminium Assoiated Group, Silvassa, India

Abstract

Increased energy consumption in industrial and commercial sectors has significantly increased the loading of power transmission lines. But with the existing lines of ACSR/AAAC conductor, it is difficult to increase the current carrying capacity since the maximum operating temperature is limited up to 75-85degC. And also operating more than aforesaid temperature will results to deviation in sag/ground clearance due to loss in conductor strength. In order to meet the power demand, there are two major ways to increase the capacity I,e. by using high temperature low sag conductors and by new transmission line. To construct new lines, the deal with Right of way (ROW) will be challenging because of increased population density, growth of infrastructures, increasing environmental concerns and cost. So, replacement of existing conductor with High performance conductor will be of suitable solution to increase the power capacity. This paper focuses on the study of various conductor solutions such as Al59, ACSS, STACIR & ACCC to

address the energy demand. The conductor performances on sag, Ampacity, Power loss and Tension on the tower were studied using PLS CADD & IEEE 738.

Reduction of Variation in Tensile Properties of AA1350-High UTS Grade Wire Rod

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Abstract

Around the globe, aluminium wire rod for electrical application is largely produced through Properzi route. Properzi is a continuous manufacturing process with several factors affecting the final wire rod properties. The present work was aimed to study various factors affecting variation in tensile properties for high UTS grade of AA1350 alloy wire rod. A six sigma approach was taken to understand the process variations. The process data for 30 high UTS grade coils along with tensile data of the respective samples were collected and analyzed to generate correlation between the two. The regression analysis was also conducted to check material related factors affecting tensile properties' variation.

To understand the effect of material related factors like surface defects, chemical composition, inclusions, porosities, grain boundary precipitation etc., surface and microstructural analysis were conducted. However, regression analysis confirmed that surface defects and chemical composition were not the major contributors, whereas inclusion content had a minor effect on tensile properties' variation. The fractography analysis conducted on tensile test specimens supported this fact with no evidence of fracture from inclusion or porosity. Also the macro analysis conducted at as-cast stage revealed interesting observations in terms of grain sizes and solidification rates for the two UTS grades.

The statistical analysis of the collected data indicated a very strong relationship between UTS and elongation. Out of all the process parameters studied, the major contributing factor for tensile properties' variation was found to be cast bar temperature, which was mainly controlled by water flow rate. Based on the study appropriate corrective actions were taken to minimize the variation in tensile properties.

Automotive Applications of Aluminium Forgings

S. Ravishankar
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Abstract

As a result of more stringent requirements for improved fuel economy and emission norms, there has been a significant growing trend to light weighting of Vehicles. Aluminium has found increasing applications to replace conventional steel & cast Iron in vehicles. From mass market vehicles such as the Ford F150 to luxury cars such as Audi, Mercedes Benz & Land Rover, aluminium has become the "material of choice" thanks to its advantages, mentioned below :

- Weight to Strength Ratio
- Superior Crash Absorption Capacity
- Eco Friendly – 90% Recyclable
- Natural Corrosion resistance
- High Thermal & Electrical Conductivity
- Ease of casting, Forging & Machining

When forged & heat treated, some of the common aluminum alloys exhibit mechanical properties comparable with many grades of steel. Being almost 3 times lighter, the strength to weight ratio of forged aluminium is therefore far superior. Aluminium also provides significant advantage in ease, cost and flexibility of manufacturing when compared to steel.

Forged aluminium also compares favorably to castings. Castings have considerably lower strength, ductility and fatigue life and often suffer from defects in the form of voids or porosity. Hence forged aluminium is preferred over castings for chassis parts, braking parts and other structural applications.

In summary, aluminium will continue to grow as the "material of choice" for many automotive applications such as chassis, auto-body and structural components. The combination of qualities of forged aluminium alloys will make it an ideal solution for applications where light-weight and strength are desired at a lower cost.

New Alloy Development for HTLS Conductor Application

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Abstract

Traditionally, AA1350-H19 alloy is being used for Aluminum Conductor Steel Reinforced (ACSR) application. Annealing of this alloy starts at 90°C causing sag beyond permissible limit. This leads to power losses during transmission. To overcome this problem zirconium, misch metal and nickel have been added in AA1350 in various wt. % in the present investigation, which offers Lower sag than conventional (ACSR) conductors at higher operating temperature (up to 250˚C). Hot extrusion route was taken for lab-scale material validation. As per ASTM B 491-10, for 3.91 to 4.70mm diameter of HTLS (High Temperature Low Sag) drawn wire, minimum electrical conductivity requirement is 60% IACS and minimum 90% of UTS retention after heat resistance test at 280°C for 1 hour. Based on these criteria, Al-Zr alloy system has been shortlisted from the three alloy variants.

In Al-Zr alloy system, sub-micron Al_3Zr precipitates form locally during solidification stage itself, due to very less wt% of Zr addition. Hence, further heat treatment is not required for these Al-Zr alloys. The Al_3Zr precipitates restrict recovery and recrystallization by acting as a grain boundary pinning agent. Results show that hot working temperature has a significant impact on achieving specified mechanical properties of HTLS drawn wire i.e. minimum 159 MPa UTS for 3.91 to 4.70mm diameter. Moreover, to achieve this higher UTS value comparatively higher strain hardening is required, as zirconium addition doesn't have significant effect on strength improvement. However, the heat resistance performance of conductor strongly depends on zirconium wt. % addition. Based on the heat resistance requirement given in ASTM B 491-10, lower specification value of zirconium addition is determined. Similarly, upper specification limit for zirconium addition is determined based on minimum 60% IACS electrical conductivity requirement mention in the HTLS standard.
After successful lab-scale validation of the HTLS alloy, plant-scale production trials through Properzi route along with wire drawing and material qualification as per ASTM B 491-10 are underway.

Texture Analysis for the Aluminium Industry

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Abstract

The electron back-scatter diffraction (EBSD) technique, also called orientation imaging microscopy (OIM) or back-scatter Kikuchi diffraction pattern (BKDP) is useful to determine the local crystal structure and orientation of single or polycrystals. EBSD is a scanning electron microscope (SEM) based technique that is increasingly applied to materials microstructural characterisation, as a tool for routine research and development work as well as for industrial quality and process control. EBSD is a technique based on the analysis of the Kikuchi pattern by the excitation of the electron beam on the surface of the sample. EBSD based Orientation Imaging Microscopy can provide several detailed information regarding microstructure which cannot be obtained by simple microscopy. It allows one to find the grain size, misorientation, micro-texture and characterize grain boundaries. This information can be utilized to understand the effect of processing on microstructure at lattice level and also help to understand microstructural evolution. Hence, EBSD can be used for quality control of ferrous and non-ferrous sheet products including aluminium. In order to improve formability or deep drawability of sheets, a proper understanding of crystallographic texture is absolutely essential and sheet textures can be studied on a sub-micron level using EBSD on an electron microscope. In this present study, commonly used strip cast aluminium alloy sheets from reputed Indian producers have been analysed using the EDAX Hikari EBSD system and relevant microstructure, colour orientation imaging and kikuchi patterns have been presented.

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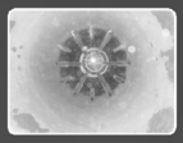

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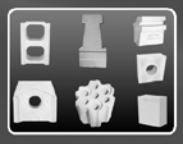

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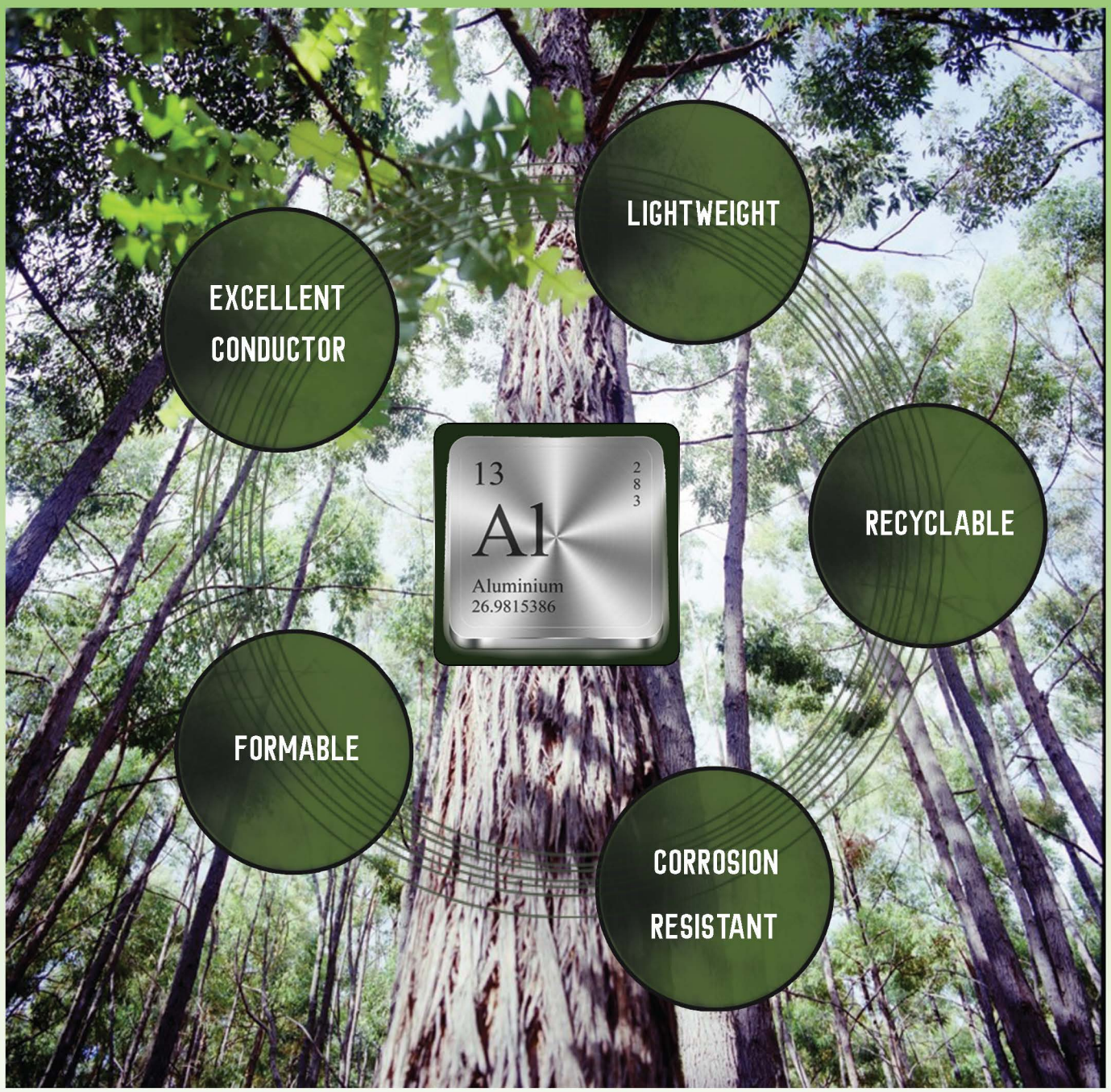

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