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Abstract book

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ICSOBA legal seat:	128 Des Fauvettes, Saint Colomban, Quebec J5K 0E2, Canada
ICSOBA contact:	icsoba@icsoba.info
	+91 9823289817
	www.icsoba.info
ICSOBA incorporated at:	Corporations Canada # 802906-7, Ontario, Canada
	Registraire d'Entreprises # 1167982181, Quebec, Canada

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SPEAKER: Fernando Simões Henriques, Head of Operations for Bauxite and Alumina at Hydro

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2. Brazilian aluminum industry

SPEAKER: Ayrton Filleti, Emeritus President and Technical Director of Abal, the Brazilian Aluminium Association.

Brazil is the largest country in Latin America, classified as an emergent country including in the named BRICS – Brazil, Russia, India, China and South Africa. Brazil has vocation to produce primary aluminium due to its huge bauxite reserves of very good quality (mainly in the Amazon Region) and the enormous potential for hydroelectricity generation. Until mid of 80's this potential had attracted important multinational companies to install aluminium plants in Brazil. Nevertheless, currently, due to the high price of energy two companies (Valesul-Billiton and Novelis) shut down two smelters, around 140,000 metric ton/ year and it is a threat for brownfield and greenfield projects in smelters. By the other hand important investments are being done in mining and refineries, mainly for exports. The author will summarize the history and the trends of the Brazilian Aluminium Industry in the near future taking into all the factors affecting the industry in mining, refinery and smelting in the scenario of cost/ energy supply, economy and sustainability issues.

3. Developments and future of the bauxite, alumina and aluminium industry in China

SPEAKER: Prof. Dr Wangxing Li, President of the Zhengzhou Research Institute of CHALCO

China is the largest producer and consumer both of alumina and aluminum in the world. The presentation will inform the advancement of alumina and aluminum industry in China in the last 10 years. However, the conflicts between the unconventional expansion and the situation of resource and environment in China are more serious than that of any other countries in the world. The new technology and equipment in alumina refining and aluminum smelting are introduced as solutions for lower energy consumption. Some of effort and achievement in waste management, i.e. bauxite tailings, bauxite residue and spent pot line also will be referable in the global industry. Some new problems in and after the great migration of aluminum electrolysis enterprises to the west-northern of China will be considered from long term. For sustainable development of the industry, some innovative standpoints for the industry are proposed in the presentation. Base on present reserve of Chinese bauxite and different predicted developing models, the strategic significance of exploring low grade bauxite, especially the alternate of bauxite resource fly ash, are analyzed and demonstrated.

4. Developments in the global bauxite, alumina and aluminium industry

SPEAKER: Dr Kelly Driscoll, managing consultant at CRU from England

This paper will focus on global market developments throughout the aluminium supply chain. In traded bauxite, there is a growing divergence between Atlantic and Pacific markets, and a threat of all exports from Indonesia being banned. In alumina, index pricing is changing consumer - supplier relationships. In aluminium, excessive stock levels are helping to depressing prices, yet premiums are at record highs. These issues will be developed, aided by supply/demand balances for each market, with a discussion on future trends.

JOINT PROGRAM - ALUMINA SUPPLY DEVELOPMENTS

1. Prospects and challenges for developing greenfield alumina refineries outside China

SPEAKER: Eric Lavalou, General Manager, Bauxite & Alumina Technology, Dubai Aluminium (DUBAL)

Between 1985 and 2011 world metallurgical alumina production outside China has more than doubled, mainly (over 85%) through Brownfield expansions. Although future demand for primary aluminium and therefore alumina is dominated by China, alumina needs outside China are expected to increase significantly, driven among others by expanding currently non integrated aluminium producers particularly those in the Middle East, including DUBAL.
These needs are expected to be covered by Greenfield alumina projects, given Brownfield expansion capacities appear strongly limited. This paper will discuss the current status and challenges in developing Greenfield projects, setting which technical, logistic and economic conditions are the key for success.

2. Alumina Rondon project

Carlos Antonio Hoffman Gatti Filho, Project and Engineering Manager, Votorantim Metais

The Alumina Rondon Project, located in the southeast of Pará State, at the Rondon do Pará city, it is an integrated alumina refinery with initial capacity of 3 million ton per year. The production start-up is estimated to be in 2016 with the first expansion in 2020, which will double the alumina production capacity and setting Alumina Rondon as the second biggest refinery in the world.
The geological researches report a potential of more than 1 billion ton of bauxite with a AA/RS above 12. Currently the project is at the feasibility study level. The pre-feasibility study indicated an estimated investment of R$ 5,6 billion with creating more than 6000 working positions during construction and about 1500 during operation.
The project adopts the sustainability concept forecasting the installation of power co-generation optimizing the use of natural resources with the innovation of the possibility use of biomass. Another sustainability action will be the solid dry-stack disposal reducing the impact on the environment.
Votorantim Metais has more than 60 year of experience on alumina production through CBA and it is a shareholding on MRN and Alunorte.

3. CAP - The Companhia de Alumina do Pará project overview

SPEAKER: Carlos Ianchuki Ferreira, Project Manager, Companhia de Alumina do Pará

No abstract is available.

4. Development of Vietnam's bauxite, alumina and aluminium industry

SPEAKER: Dr Quoc-Khanh Tran, Principal Mechanical Engineer at Hatch Associates Pty Ltd

Vietnam's bauxite reserves in 2007 totaled approximately 5.5Gt. These reserves consisted of ~91Mt of diasporic bauxite in the northern regions, and ~5.41Gt of gibbsitic bauxite in the southern region, mainly in the highlands. Since 2007, the quality and quantity of Vietnam's bauxite reserves has increased as a result of improvements in exploration techniques and continued exploration in the Central Highlands region. By 2010, Vietnam's bauxite reserves had increased to 10.8Gt, which is equivalent to 4.6Gt of beneficiated bauxite. The quantity of reserves identified appears to warrant the establishment of critical infrastructure for mine developments. The Vietnamese government plans to develop an integrated bauxite, alumina, and aluminium industry. In this respect, the 0.65Mtpa Tan Rai Alumina Refinery was built by Chalieco in Lam Dong province. Under the original agreement, the Tan Rai Alumina Refinery was to be completed in October 2010; however, at this point in time

commissioning has not yet started. A second alumina refinery in Dak Nong province, the 0.65Mtpa Nhan Co Alumina Refinery, has also been built by Chalieco and is expected to be commissioned in December 2012. Alumina produced by these two refineries will be exported. These two refineries are facing a huge infrastructure cost. There are a number of other proposed bauxite and alumina projects in Vietnam that are currently in the study stage. To ensure that these bauxite reserves are developed in a sustainable manner, the government is re-planning the Bauxite-Alumina-Aluminium Roadmap taking into account geographical positions, infrastructure requirements, environmental impacts, accessibility, further prospects and economic value of proposed projects to the provinces. It is expected that the Roadmap will be approved in late 2012. This paper will discuss Vietnamese bauxite deposits, the Roadmap for sustainable development of the Bauxite-Alumina-Aluminium industry, infrastructure needs, and possible environmental impacts.

BAUXITE PROGRAM

1. Bauxite deposits in North Brazil - What it takes to make a mine

SPEAKER: David Sugden, owner and consultant at WHEB52 Ltda from Brazil

Part 1 of this paper indicates the locations of known bauxite occurrences in the Amazon region of Brazil. It comments the nature and origin of the deposits and provides a general description. Features of important deposits are presented in the light of the generalized profile, together with remarks about the characteristics and variations that could affect project development. Part 2 provides a map of exploration and development interest, based on published information, and considers the drivers for location of the operating bauxite mines. A personal view is offered, with respect to aspects of project development and implementation; including infra-structure, logistics, environmental constraints and market opportunity. The final part adds some considerations of doing business in Brazil to round-up an appreciation of what it takes to make a bauxite mine in North Brazil.

2. The Barro Alto bauxite deposit, a large and rich bauxite deposit recently discovered in the Goias state, central Brazil

SPEAKER: Tadeu Veiga, technical director of GEOS – Mining Geology Ltd. from Brazil

The Barro Alto bauxite deposit is the first significant bauxite deposit discovered in the Central Brazil. It is situated 200 km West to Brasília, in a region served by good infrastructure (paved roads, rail, energy, human resources, etc.). The bauxite is the lateritic saprolite of anorthositic rocks, which constitute a large mafic-ultramafic complex of Neoproterozoic age. This establishes a new genetic-exploratory model for bauxite in the Country. The exploration works are in advanced stage and delineate a large outcropping deposit, inspected by drilling (auger, diamond, RC), pits and trial mining. Total resources reach 300 million tons of ore, including high-grade bauxite, low-grade bauxite and associated kaolinite. The excellent quality of the bauxite permits several industrial uses for the ore, out of the classic metallurgical application.

3. Identification of mineral texture types in Brazil's southeastern Bahia bauxites

SPEAKER: Dr. Jeannette See, program manager for bauxite and alumina research & development at Rio Tinto Alcan's Arvida research and development centre in Quebec, Canada

Bauxites discovered in the State of Bahia in Brazil occur in a region where more than one protolith has undergone granulite-facies metamorphism prior to leaching by the weathering process (laterization / bauxitization). Understanding mineral liberation properties is essential in determining appropriate processing technologies, mainly in relation to beneficiation potential. Reliance on automated techniques has sometimes neglected the use of traditional optical microscopy. This study aimed at identifying the mineralogy and mineral texture types that exist in this newly discovered bauxite, currently under investigation through optical transmitted and reflected light microscopy, complemented by Electron Microscopy. The study is also supported by X-Ray Diffraction (XRD) and Scanning Electron Microscopy, being the latter interfaced with Energy Dispersive Spectroscopy (SEM/EDS). Results indicate that samples with low to high alumina content, overlying rocks of basic to ultra-basic composition (metagabro, metanorite, etc.) have gibbsite content varying between 30 and 70% with clay minerals including kaolinite, halloysite, and iron phases, mainly goethite, magnetite and low quartz. Bauxites developed over acid to intermediate rocks (charnockite, charno-enderbite, etc.) are formed mainly of gibbsite with high quartz content and low iron oxides and hydroxide content. Their textural relationship through optical microscopy led to the identification of specific textural types that will impact on the choice of beneficiation methods for this type of bauxite.

4. Suriname's Bakhuis Mountains bauxite resources and their commercial potential

SPEAKER: Drs. Rita Vaseur-Madhoeban, director of Bauxiet Instituut Suriname

The Bakhuis Mountains, located in the west of Suriname between the Kabalebo River and the Coppename River, form a chain of mountains of approximately 25 km wide and 95 km long. The findings of the 2003-2005 bauxite drilling programme carried out on the Bakhuis Mountains which resulted in a mineral resource statement for the Bakhuis bauxite deposits in compliance with the Australasian Code for Reporting of Identified Mineral Resources and Ore Reserves, are described together with the findings of studies on the Kabalebo hydropower potential and the challenges and opportunities for the commercial development of these resources.
The total reportable resources of 325 Mt with an average grade of 1,9% Reactive Silica and 38,5% Available Alumina and the 450MW-650MW hydropower potential in the Kabalebo area provide the opportunity for an integrated bauxite to aluminium complex in Suriname while site, logistic and environmental challenges will have to be bridged. This project would include mining bauxite from the Bakhuis area, transporting it to a refinery and transferring alumina to a 160,000tpy–200.000tpy aluminium smelter for reduction into primary aluminium ingots. Exports would consist of alumina and aluminium ingot. Combined with other new downstream facilities in the Caribbean, significant economies could be realized.

5. First Bauxite's greenfield refractory-grade bauxite mine and vertical shaft sinter plant in Guyana

SPEAKER: Jess Hutchinson, Vice President - Market and Product Development at First Bauxite Corporation.

This paper will present an overview of the Canadian startup company First Bauxite Corporation (FBX) whose goal is to produce high quality, sintered Guyana s bauxite for the refractory industry. This is significant because FBX will be the first company not currently based in China or controlled by Chinese investors that will mine, beneficiate, sinter and export refractory grade bauxite to the global market. Information regarding current demand for refractory grade bauxite will be given as well as market dynamics that are encouraging entrance of a non - Chinese supplier. Details showing the extent of FBX's 13.1 million tonnes of proven bauxite reserves in Guyana and planned operations of the wash and sintering plants will be presented. Highlights of the feasibility studies and update conducted on FBX deposits will also be mentioned. The sinter plant will carry bauxite sinter technology to a new level by incorporation of vertical pressurized shaft kilns from Polysius. Properties of Guysin® sinter as well as limited test results of products made with the sinter will be discussed. Generalized flowsheets of the process and the construction and commissioning schedule will conclude the FBX presentation.

6. Socio environmental management of a bauxite enterprise in a conservation sustainable area in the Brazilian Amazon

SPEAKER: Ademar Cavalcanti Silva Filho, consultant on sustainability and head of SCI-Fractal-Integrated Consulting System for Sustainability Ltda from Brazil.

Brazilian environmental legislation recommends policies for the sustainable development projects associated with large environmental impact. MRN - Mineração Rio do Norte is an enterprise engaged in the bauxite production in the Saracá-Taquera National Forest, Pará State, in the central Brazilian Amazon. MRN develops its shares in accordance with the law, and also according to principles of environmental and social sustainability. In this view, MRN develops activities to support regional communities in the education, health and production areas, in addition to conducting several research projects, monitoring and conservation of flora, fauna and water resources. This translates the social and ethical behavior in its essence, the sum of the paths taken by the Company through conquest and harmony among employees, community and environment, resulting in sustainable economic and social development and improving the quality of life of the regional population

7. Environmental control of Parariquara water quality, upstream and downstream of Mineração Paragominas

SPEAKER: Ricardo Dias Caruso, environmental supervisor at Mineração Paragominas from Brazil

Monitoring environmental performance of mitigation measures, implemented by Mineração Paragominas, aims at evaluating the level of inference of bauxite mining on water quality in the Parariquara River area. The study considered historical monitoring data, for the period from 2005 to 2011, for physico-chemical parameters such as pH, turbidity, total aluminum, total iron, total suspended solids, settleable material and total dissolved solids. The results are evaluated for reference points PS04 and PS09 that best represent the water quality upstream and downstream in the Parariquara River. The results show how environmental control minimizes the impact of mining on Parariquara River water quality.

8. Asset management and life cycle cost

SPEAKER: Felipe Dreyer, mechanical engineer at Mineração Paragominas from Brazil

Today, in the global economy and due to various other markets pressures, the acquisition equipment decisions of many engineering systems, particularly the expensive ones, are not made based on initial procurement costs but rather on their life cycle costs and its reliability (failure projection analysis). There are two different procedures to calculate the Life Cycle Cost of an equipment or system. The first one concerns to choose one among various purchase options. This approach says the life cycle cost of a system may be defined simply as the sum of all costs incurred during its life span. The best purchase is the smallest cash flow. This paper is related to the second procedure. It shows how to find the renewal point from equipments or even a fleet. The renewal point is given by the minimum ownership cost. For old equipments the ownership cost generally converges to a minimum. When the ownership cost function does not converge to a minimum value (new equipments or slow aging), this paper shows how to solve this problem using a Numerical Method of Particle Swarm Optimization.

9. Dredging as an asset in bauxite mining

SPEAKER: Bob Scheiberlich, commercial manager earthmoving and mining at Boskalis from The Netherlands

The objective of this paper is to introduce dredging technology as an asset in mining of Bauxite. Earthmoving by dredging is applied in a wide range of activities of which port construction and maintenance and land reclamation are most well known. Dredging is also well established in on- and offshore mining of sand and aggregates with recent developments towards deep sea offshore mineral mining. Less well known is the application of dredging techniques in onshore mining of minerals, in particular in Bauxite mining. This paper gives an overview of dredging techniques and equipment applied in earthmoving and discusses the application of dredging as an asset in onshore mineral mining. Last but not least, the paper covers a case study on integration of dredging techniques with traditional dry earthmoving methods at the Lelydorp I Total Mining Project in Surinam. This project is now under execution and was recently awarded by Suralco/Alcoa to Boskalis International b.v..

10. The MMD Sizer for bauxite size reduction

SPEAKER: Andrew B. Dodman, project director (Americas) for MMD, an independent worldwide company that remains focused on Sizer solutions

The MMD Sizer technology has proven as the best available technology to crush bauxite ores, with dozens of MMD Sizers specifically deployed on projects both in lateritic and carbonatic bauxite, reaching in some cases production rate of more than 3,000TPH. The new concept in bauxite crushing is now the standard. Easily relocatable and with minimum civil works, the modular MMD SIZER Semi Mobile Systems supplied by MMD are reaping the maximum benefits of the more efficient IPCC with no compromise of the system in the wet clay laden operation of the bauxite mine. Comprising both primary and secondary MMD Sizers within the same semi mobile unit, MMD have

consistently being a world leader in this market. With many deployed applications spread across Australia, China, Jamaica and Brazil, for over 27 years, MMD Sizer technology for bauxite ore has undoubtedly proved its performance, efficiency and reliability under heavy duty operations and adverse environmental conditions.

11. High pressure grinding rolls for bauxite size reduction

SPEAKER: Frank Peter van der Meer, principal metallurgist, minerals processing and high pressure grinding roll technology at KHD Humboldt Wedag from Cologne, Germany

High Pressure Grinding Roll ("HPGR") technology is applied is a broadening range of applications. In the last few years, increasing numbers of HPGR units have been or are being installed in minerals processing projects such as gold, diamonds, copper, iron, and iron ore pellet feed, and further installations will start in nickel, lead and zinc operations this year. HPGR application is also being considered for bauxites or alumina, given the potential benefits of a high unit capacity (up to 2500 TPH per unit), high availability (92-97%) and high size reduction efficiency. Bauxite ores have been tested from various deposits. This publication summarizes some of the results achieved and observations made during this test work, including relationships of specific throughput, energy and size reduction in relation to operating parameters of press force, roll speed and moisture content. In this context, HPGR sizing, circuit design and product handling will be touched upon, and the expected performance and maintenance aspects of HPGR will be discussed for bauxite applications. This does include a projection of capital and operating cost.

12. The application of the RopeCon® System for bauxite transport

SPEAKER Paulo Lambert, commercial director at Tecnologia em Movimentação from Brazil

Bringing the bauxite from where it is mined to the process plant is only a small part of the entire production chain of aluminum. Sometimes, however, this part presents serious difficulties for conventional conveying techniques, thus hindering the overall material flow. This paper aims to present an alternative means of transport, the RopeCon®, which was installed at Jamalco's South Manchester mine in Jamaica to overcome such difficulties. The RopeCon®, developed, manufactured and installed by the Austrian company Doppelmayr Transport Technology GmbH, links the new mine with the railway at St. Jago. The aerial conveying system transports 1,200 t/h of sticky bauxite over a distance of 3.4 km and a vertical descent of 470 m. The footprint of the system is very small as it only counts with 10 towers along the route and its quiet and clean operation reduces disturbances of the environment to a minimum.

13. On-line moisture measurement of bauxite ore on conveyor belts

SPEAKER: Sidney Viana, process control projects specialist at Mineração Paragominas from Brazil.

The production and quality control of mineral processing plants rely on the use of suitable field instruments and analyzers to measure the major process variables. For such plants, an important process variable is the moisture content of the ore, which represents the amount of water naturally absorbed by the ore, and whose measurement is necessary to determine the mass of solely the ore, referred as its dry mass. The traditional and obvious way to measure moisture content of ores is by heating them, under specific conditions, and hence comparing their initial wet mass to their final dry mass. But since this requires the ore to be sampled, handled, and heated, it's usually hard-working and time-consuming. However, in present days there are field analyzers for on-line measurement of moisture content that can be used with advantages over the traditional measurement way, provided that they are well designed for the application of interest. In this context, this paper presents the application of an microwave-based analyzer to the on-line measurement of moisture content of bauxite ore, at the HYDRO's Bauxite Concentration Plant, in Brazil. The results and benefits of the use of an on-line analyzer are also discussed.

14. Rapid X-ray diffraction (XRD) for grade control of bauxites

SPEAKER: Dr. Uwe König, product specialist at PANalytical from The Netherlands

Brazil is besides Australia and China the 3rd largest producer of bauxite worldwide. 97% of the deposits are concentrated in the Amazon region. The first part of the paper gives an overview about the distribution, types and reserves of the Brazilian bauxite deposits in terms of petrology, geochemistry and mineralogy. The mineralogical phase composition plays an important role in classifying the grade of an bauxite ore. Optimal mining and process operations (refinery, electrolytic bath conditions etc.) require faster and more accurate analytical methods. The use of high speed detectors let X-ray diffraction (XRD) became an important tool for quality and process control in mining and aluminum industries. It provides useful information in terms of quantification of the crystalline phases and the amorphous content of an bauxite ore sample and allows the calculation of process critical parameters such as available aluminium or reactive silica. The second part of the paper demonstrates the use of XRD for comparing and analyzing several Brazilian bauxite deposits with other deposits from different parts of the world. Cluster analysis as well as alternative reliable quantification methods will be presented besides known methods such as Rietveld or calibration based analysis.

15. Mineralogical characterization of Brazil's south east Bahia bauxites with SEM/ED/MLA and XRD/Rietveld method

SPEAKER: Dr. Jeannette See, program manager for bauxite and alumina research & development at Rio Tinto Alcan's Arvida research and development centre in Quebec, Canada

Bauxites from the southeast region of Bahia State, Brazil, are currently under investigation. A multiple analytical approach to characterize its mineralogical compositions was adopted. This study summarizes the results from wet chemical analysis which is compared to results obtained by Scanning Electron Microscopy with Energy-dispersive X-ray spectroscopy (SEM/EDS) controlled by an MLA system, as well as of X-Ray Diffraction (XRD) with quantification by the Rietveld Method. Results lead to characteristic mineralogical assemblages of typical and anomalous samples, the ability to compare qualitative and quantitative chemical compositions as well as their liberation properties.

16. X-ray diffraction (XRD) studies of kaolinites to support mineralogical quantification of high silica bauxites from the Brazilian Amazon region

SPEAKER: Dr Rômulo Simões Angélica, associate professor at the Federal University of Pará in Brazil

Mineralogical phase quantification is still not very common in the mining industry, in comparison with quality control using chemical analysis. Concerning bauxite ores, it is still more difficulty due to complexity of the minerals presents (poor crystallinity/small crystallite size, abundant solid-solutions, frequent intergrowth, etc.). Mineralogical phase composition studies from powder diffraction data have increased rapidly in the last years, but there are still some challenges related to bauxites quantification. For instance, the lack of crystallographic information related to several phases in bauxites, e.g. kaolinite and aluminum-goethite. Different works mentioned the occurrence of several generations of such minerals during lateritic weathering profile development. In this work, a XRD whole-pattern decomposition method was used for the lattice parameters determination of kaolinites from profiles geologically related to high silica bauxites from the Paragominas region, Pará state, northern Brasil. Crystallographic data obtained from difractometric profile of these kaolinites can be very useful in refinement studies (e.g., Rietveld and Le bail methods) and consequently in phase quantification of the Amazon bauxites.

17. Bauxite XRD cluster for the prediction of mineral processing behavior

SPEAKER: Juliana Livi Antoniassi, geologist at the Polytechnic School of the University of São Paulo, Brazil

X-ray diffraction (XRD) cluster analysis in support of mineral exploration and mining operations has been highlighted in recent ore characterization and geometallurgical studies. This tool enables the definition of geological domains or ore types with distinct mineralogical compositions and their potential implications in mineral exploration and/or processing behavior without the need for deeper XRD expertise. The simultaneous analysis of a large number of scans by mineralogical similarity reduces the number of data to be treated once it is possible to select the most representative scan from each cluster for further analyses. The blending of a large set of samples also minimizes the number of mineralogical, metallurgical and minerals separation assays, reducing time and costs of the ore evaluation. In this study, 69 bauxite samples from Porto Trombetas, Brazil, were classified by cluster analysis. Results led to six groups and their subgroups, which correspond to the different geological weathering horizons of bauxite formation, each with different gibbsite, clay mineral and iron bearing mineral content. Scrubbing, size classification and mineral separations were conducted for each sample. The results demonstrated that samples from the same cluster present similar chemical and mineralogical compositions as well as an equivalent behavior on the mineral separation assays.

18. Reasons for bauxite beneficiation

SPEAKER: Ricardo Moreno Rachel, process engineer at Hatch in Brazil

Caustic soda is responsible for more than 15% of the operational cost in an alumina refinery. It is needed to complement the amount lost on the hydroxide and residue and also the amount consumed in the desilication process. Due to the high grade of reactive silica in the Brazilian bauxite ores the Brazilian mines have a beneficiation plant to reduce the reactive silica by removing the finer fraction of the material, usually under 400#. The OPEX reduction achieved due to the reduction of the reactive silica by washing makes the beneficiation plant pay itself generally in less than three years.
Besides the operational cost reduction, the beneficiation plant diminishes the refinery energy consumption and residue generation amount. To proper select the equipments and technologies, it is necessary to properly characterize the bauxite. The first step is usually to do a chemical analysis per size fraction. Other tests are lab scale of the unit operations considered in order to evaluate the possible parameters in an industrial plant.

19. Operating experience with the Paragominas bauxite wash plant

SPEAKER: Fábio Araujo Mendes, process development and laboratories manager at Mineração Paragominas in Brazil

The processing plants Mining Paragominas SA which began operations in March 2007 the first plant and, in May 2008 the second plant, consisting of a sequence of operations of homogenization, comminution and particle size distributions that aim primarily to increase the chemical quality its bauxite ore by the removal of fine natural clay as well, offering for transport by pipeline to a pulp concentrate rheological and textural conditions suitable for safe operation of transport. It also aims to deliver back to nature its waste of natural ultrathin (sludges from washing), securely, using a system of dams cyclic tailings disposal areas occupied easement. Still operating, a thickener system that maximizes the reuse of water in their process improvement, avoiding too much water intake further minimizing the environmental impacts that would be created by this demand. The latter two systems aim to make processes more reputable and environmentally friendly.

20. Bauxite tailings paste thickener design from laboratory to pilot to industrial scale

SPEAKER: Steve Slottee, process engineer at WesTech Engineering from the United States

Many process equipment designs, such as for conventional thickeners, are selected from data based on well established operating theory and models as well as full-scale operating experience over many years. Some equipment designs, such as for a paste thickener, are relatively new in industrial use. Paste thickener design requires empirical testing, combined with a developing theory and model of operation. A high density thickener producing paste (non-settling, non-segregating suspension) from bauxite tailings is an example where different levels of empirical testing, each with associated scale-up methodology and uncertainty, are combined with an evolving operating model to achieve a final design and an operating paste thickener. The testing is a progression from laboratory tests in an 80 mm diameter, 400 mm high static column to a 1 m diameter, 4 m high continuous pilot thickener test. An operating model based on other applications is applied to the test data. A final mechanical design is then produced resulting in an operating 45 m diameter paste thickener. Using the operating results of the full-scale thickener, the empirical testing procedures and operating model for this application are evaluated and adjustments made if required.

21. Disposal methods for fine tailings

SPEAKER**:** Joaquim Pimenta de Ávila, consultant in civil and geotechnical engineering and president of Pimenta de Avila Consultoria from Belo Horizonte in Brazil

The processing of bauxite ore uses frequently a washing process that results in the production of tailings with fine gradation and with a high water content with unfavorable characteristics for disposal, in the state that they are released from the processing plant. In order to increase the density of the tailings, for a more manageable consistency for disposal the thickening of the tailings have been made by several means but, in most of the cases, the thickened tailings are still dilute because of difficulties in the thickener process or because the more dense tailings are not easily pumped.
A presentation of a series of methods for disposal of these tailings related to their characteristics and the associated performance of the various methods is presented in the paper. The several aspects are discussed, related to the objectives of the methods: increase density, decrease the risks of environmental damage, closure conditions, pumpability characteristics etc. The promising recent tendency of a strong dewatering of the tailings and residues for obtaining the improved performance of disposal method, is emphasized and discussed with examples of two projects being studied using this method.

22. Trade-off study for bauxite reject disposal

SPEAKER: Caio Moreira van Deursen, senior mining engineer at Votorantim Metais from Brazil

The Alumina Rondon Project will have a production capacity of three million tons of alumina per year. For this production, approximately 10.7 million tons of ROM will be necessary and the beneficiation will dispose around three million tons of reject. The goal of this study is to evaluate different way of treatment, handling and disposal of the generated reject. The comparison was made in terms of CapEx, OpEx and NPV. The compared KPIs are CapEx and NPV, both on the year of 2015. Seven scenarios were evaluated, varying the combination between ways of constructing the reject ponds, recovered and raw water ponds, and launching the reject as generated on the beneficiation plant, thickened, super flocculated and filtered on horizontal press filters. The super flocculation option has the lowest CAPEX while the press filtered option with pile disposal has the lowest NPV.

23. CBA's Miraí processing plant

SPEAKER: Arthur Pinto Chaves, full professor at the University of São Paulo, Brazil and process engineer at Progen.

CBA's Miraí is a modern bauxite process plant. It has been designed in four modules which will successively be implemented. The circuit has two different parts, designed as "coarses" circuit and "fines" circuit. The coarses circuit is a conventional washing circuit, with scrubbers and screens. It is in industrial operation and its performance is described and discussed. The fines, tail of this circuit will be processed by densitary separation in concentrating spirals and by reverse froth flotation plus magnetic separation. This circuit will be put in experimental operation during this year. The process

development is described in this paper. The plant and overall project considered environmental constraints, full automation and supervisory control.

24. Reduction of reactive silica from bauxite

SPEAKER: Fernanda Arruda, professor in the field of inorganic chemistry at the Institute of Chemistry at the Federal University of Rio de Janeiro

Some bauxite has a high chemical content of reactive silica and other impurities, being considered marginal bauxite. Nowadays, these bauxites are not used for the production of alumina by the Bayer process, such as the marginal bauxites from Northern Brazil. The detailed study of characterization showed that theses bauxites contain particles of kaolinite associated to gibbsite. With this knowledge, a methodology was developed in order to promote the reduction of reactive silica. Therefore, the particle surface modification, by chemical reaction, associated with the screening promoted a decrease, approximately, 75% of reactive silica in the fraction above 37 μm. After this treatment, the marginal bauxite studied showed a proportion of available Al2O3 : reactive SiO2 (> 10:1), suitable for its use in the Bayer process.

25. The application of bauxite tailings in synthetisation of geopolymer

SPEAKER: Dr Wanchao Liu, research director of waste management group at CHALCO's Zhengzhou Research Institute

With the lowing of bauxite grade in China, the flotation beneficiation is widely used in alumina refineries. The disposal of bauxite tailings is a new environmental problem in refineries. On another hand, the requirement for inorganic heat preservation building materials is great. The paper will present the research in insulating building materials from bauxite tailings with sintering process and geopolymer process. The foundational analysis on strength formation and insulating property will be researched. The work will propose a possible solution on the tailing utilization..

26. World-class piston-diaphragm pumps for bauxite pipeline transport

SPEAKER: Ted Beekman, regional sales manager at Weir Minerals in The Netherlands

New bauxite deposits are located in more and more in remote areas, requiring long distance ore transportation to areas with better infrastructure or ports. In practice a choice has to be made between different transportation methods, including pipeline transport. The world's first bauxite pipeline is in successful operation since six years in Paragominas. Pipelines follow the shortest route because they can be built straight across or over mountains. Investment costs are affected by the requirement of additional crushing, a slurry make up system and a dewatering system at the final destination, yet total cost per ton are low because of low energy consumption and low maintenance requirements.
Several design features have been introduced to piston diaphragm pumps over the past 25 years to develop maximum pump capacity and pressure along with specific ore pipeline requirements, whilst constantly optimizing the pump performance and reliability and reducing the maintenance requirements. The GEHO development of the patented GLORES system (Geho LOad REduction System) increased possible power rating of the triplex piston diaphragm pump to 2800 kW. As a result, GLORES can reduce the total number of pumps required.

27. Analyses of critical velocity of bauxite slurry flow through the pipeline

SPEAKER: To be announced

The mining industry is a major stimulator of the state economy, and as highlighted in this industry sector we can mention the processing of bauxite. Solutions to problems related to this activity are shown as a rare opportunity for interaction between university and industry, besides being a breeding ground for scientific development. An important point to be studied is the flow of the suspension of bauxite in pipelines and related equipment, problems such as scaling and calculation of pressure loss have not yet been definitively resolved by the industry. In this context the present work sets out to

develop a methodology for calculating the flow parameters especially the minimum speed required for the particles in suspension settle to the interior of the ducts. So the macro goal of this paper is to analyze through the implementation methodology, calculate the rate of deposition during the flow of bauxite slurries with different mass fractions (% by weight of solids) inside a circular duct, from the rheological study samples obtained in the process of processing, thereby providing, theoretical subsidy technicians and engineers who wish to scale a pumping system applied to pulps bauxite, minimizing their problems of under and over sizing, which causes the deposition of the material, causing damage to production and the environment, since it will need to open the pipe to remove deposits from the low speed.

28. Continuous filtration of pipelined bauxite slurry

SPEAKER: Dr. Reinhard Bott, managing director of BOKELA from Germany

Transport of beneficiated bauxite via pipeline from mine to refinery is a very economic and environmental alternative to conventional transportation methods. Pipeline transport of bulk materials such as kaolin or iron ore is not only a proven but also a more economical and environmental method than ship, truck or railroad transport. This new method of bauxite transport has been realized for the first time in Brazil. The bauxite is milled and mixed with water at the mine and the slurry of some 50 wt-% bauxite is pumped to the refinery where it has to be dewatered prior to digestion. Bauxite filtration requires a high performance filtration technology due to the special product characteristics and process requirements. With continuous pressure filtration the required low cake moistures are achieved with large specific throughput rates, which keep the required filter area small. A first filter plant for dewatering of pipeline-transported bauxite is operated in Brazil. This hyperbaric filter plant was realized by a consortium of BOKELA and Andritz. Each filter of 168 m² filter area achieves a specific solids throughput of some 710 kg/m²h and a moisture content of mc < 14 wt-%.

29. Microbial diversity in samples of mined bauxite and its ability to form biofilm

SPEAKER: Thaís Abrantes Rodrigues, microbiologist at the National Institute of Technology from Brazil

Microorganisms are widely distributed in different environments and participate in various biogeochemical cycles. Their presence can cause changes in the metal / solution interface, allowing biocorrosion. This effect can be observed in various industrial activities, including the process of bauxite mining. Several microbial groups can participate in the process of biocorrosion, directly or indirectly. Some genera have the capacity to adhere to surfaces that offer favorable conditions for their development, forming structures called biofilms. Biofilm formation is a cumulative process, dynamic and often non-uniform, and may cause decreased efficiency and lifetime of material. This study aims to monitor in various stages of bauxite mining microorganisms related to biocorrosion. We highlight the groups most frequently encountered: precipitating iron bacteria, sulfate-reducing (SRB) bacteria, and fungi. Moreover, the microbial diversity of these samples was analyzed using molecular biology techniques, which also allowed for the identification of uncultured microorganisms. To observe the ability of biofilm formation by microorganisms present in samples of bauxite, process water and bauxite pulp were analyzed through confocal and scanning electron microscopy. The results allow us to have greater access to and understanding of microbial diversity in this environment, thus facilitating actions that maintain the integrity of pipelines against microbial attack.

30. Corrosion and corrosion-erosion evaluation and proposed mitigation treatment for bauxite slurry pipeline

SPEAKER: Danilo Zim, senior research chemist at Ecolab (formerly Nalco Co.) in Brazil

The occurrence of corrosion as well as corrosion-erosion processes may take place during pumping of bauxite slurry (pulp) in pipelines. Norsk Hydro has a bauxite ore mine located in Paragominas-PA, Brazil and the first bauxite pulp pipeline in the world. The designed lifetime of the pipeline is 25 years. In order to ensure this, an evaluation of both the river water and bauxite pulp's corrosivity was

requested. The objective of this study was to report the results obtained for corrosion and corrosion-erosion aspects, as well as propose mitigation actions for each case. Comparative results using pulp already used for several years without major corrosion-erosion issues are also reported in order to validate the laboratory methodology. For the river water, it was possible to identify the occurrence of localized corrosion. For pulp, it was possible to identify the occurrence of corrosion (C), erosion (E), and synergistic effect (SyCE). In order to have significant corrosion inhibition in the bauxite pulp medium, it was necessary to pre-treat the metal surface. The corrosion inhibition in bauxite pulp using corrosion inhibitor (A) after pre-treatment was 49%, and is comparable to cathodic protection according to laboratory data. Results of the industrial trial are presented.

31. Rheological behavior of bauxite slurry in presence of rheology modifiers.

SPEAKER: Paulo Martins, technical service representative for Dow Brasil

Despite the growth in global aluminum demand having decreased in 2012 as a result of current economic turbulence, the long term prospects of aluminum remain very promising and highly encourage the increment on the plant operational performance. The pioneer transportation of Bauxite slurry through large distance pipelines in Paragominas – Brazil, motivated this rheological study in order to supply the transportation demand of higher concentrated slurries. The rheology properties are influenced by slurry concentration, particle size distribution, temperature and interaction among particles. The results of this rheology study considered the influence of those parameters and also the response of using rheology modifiers on viscosity and yield stress of concentrated bauxite slurries.

32. Study of a bauxite slurry pipeline from Vietnam's highlands to the coast

SPEAKER: Dr Quoc-Khanh Tran, principal mechanical engineer at Hatch Associates

Vietnam's bauxite resources are mainly found in the Highlands region, which is also home to the upper catchment areas of some of Vietnam's most significant river systems. The location of alumina refineries in the Highlands region with their associated residue disposal facilities raises serious environmental concerns. The tropical climate zone brings periods of intense monsoonal rainfall that needs to be contained and managed. The likelihood and impact of fugitive dust emissions, ground water contamination, or discharge of contaminated water streams must be minimized. The existing infrastructure for transportation of raw materials, refinery supplies and product alumina to and from the refinery is also limited. Therefore, potential investors will have to pay high costs to minimize the environmental risks and to upgrade and improve transport infrastructure in order to build and operate their refineries in the Highlands. One potential solution to these problems is to locate future alumina refineries closer to the coast some distance from the mines and beneficiation plants in the Highlands. In coastal locations, residue disposal can safely be neutralized and stored using sea water and alumina product can easily be transported to a nearby port. A Vietnamese alumina project has now been proposed to build a mine and beneficiation plant in the Highlands (K'Bang, Gia Lai) and the refinery close to the coast (Quy Nhon, Binh Dinh). The connection between the two plants will be via a bauxite slurry pipeline. This paper describes the technical aspects of the pipeline design, operating and control philosophy, maintenance, and capital and operating cost.

ALUMINA PROGRAM

1. Improving earnings through a certified energy management system

SPEAKER: Damien Clancy, Managing Director of Rusal Aughinish in Ireland

RUSAL Aughinish produces 1.94 Mt/year of metallurgical grade alumina using the high temperature Bayer process. Energy accounts for 25-30% of the operating cost and optimising energy efficiency is a key management objective. In 2004 the plant implemented a formal Energy Management System based on the Danish Standard DS2403. This was the only energy standard then available and Aughinish was the first alumina plant in the world to be certified in this way. DS2403 committed the Management Team to continuous improvement in energy efficiency. Between 2004 and 2009 we used the system to identify key areas for improvement and we implemented projects which made a significant contribution to improving energy efficiency. The procedures required setting challenging but achievable energy targets, effective monitoring of performance, and taking action to resolve issues which prevented us achieving targets. In addition to regular reviews at local level we also held quarterly Management Energy Reviews to ensure that the Management Team was fully aware of the key energy aspects. Total steam efficiency averaged 7.36 GJ/t from 2001 to 2003. This reduced to 5.86 GJ/t in 2008, an improvement of 20%. Many factors contributed to this change; we believe that the impact of the energy management system was 30% of the total or 0.45 GJ/t. In 2009 the European Standard EN16001 replaced DS2403 and in 2011 ISO50001 became the first international energy management standard. We plan to get certification to it by end 2012.

2. History and current status of bauxite digestion

SPEAKER: Dr. Alessio Scarsella, Head of Alumina Refineries at Outotec in Germany

Core of the Bayer process is the digestion of bauxite where aluminum compounds are transformed into soluble sodium aluminates which by several further process steps are converted to alumina. Since the invention of the leaching procedure under pressure by Carl Josef Bayer until the 1940's digestion was carried out in batch wise operating autoclaves with poor plant efficiency. Development on a continuous process had begun since 1941 with a row of continuously operating autoclaves and was improved by various process concepts until today. The paper describes the history of the most important process concepts for bauxite digestion up to the current status of bauxite digestion technology. The latest technology of the continuously operating tube digester, which was originally introduced to the alumina industry through VAW and further developed with VAW/AOS and OUTOTEC (once LURGI) to a modern efficient digestion process will be presented. Advantages of the improved digestion technology such as easier operation, easier maintenance and cleaning, higher energy efficiency, lower capital cost as well as the possibility of using safe wet oxidation to reduce the organic C-level are described. The paper further describes references of the improved technology backed up with data of operating plants.

3. Utilizing waste energy for evaporation in the Bayer process

SPEAKER: Hans Haraldsen, Principle Engineer, Hydro Aluminium

With the increased focus on reducing greenhouse gas emissions and the forecasted future energy costs, new approaches to more efficiently use energy in alumina refineries are needed. An alumina refinery uses above 3 GJ/t alumina energy in the Bayer circuit (excluding calcination, steam and power generation), mostly as steam in digestion and evaporation. A large part of this energy is normally discarded as low grade energy through cooling towers in precipitation and evaporation.
In this paper a concept of using low grade waste energy currently discarded through the precipitation cooling towers for evaporation is presented. This concept significantly reduces the steam requirement for evaporation and thereby the Bayer Process energy consumption and greenhouse gas emissions.

4. Cost and energy efficient pumping of bauxite slurry in sweetening processes

SPEAKER: Rudolf Gänsl, Managing Director, FELUWA Pumpen from Germany

Sweetening digestion processes are applied with the objective of processing additional bauxite within the digestion unit whilst making a noticeable improvement in the energy balance of the digestion heat recovery system. Charging of sweetening bauxite slurry to digestion requires high pressure pumps. The use of hose-diaphragm piston pumps offers distinct advantages compared to traditional piston diaphragm pumps. At the heart of MULTISAFE pumps are two hydraulically actuated hose-diaphragms, which are arranged one inside the other. They fully enclose the bauxite slurry and create double hermetic sealing from the hydraulic drive end. The cylindrical shape of the diaphragm favours flow behaviour and avoids settling of solids. Hose-diaphragm pumps ensure a high energy efficiency of 97% and provide for unique operating reliability. Permanent condition monitoring of check valves avoids loss of energy, because any decrease in output resulting from valve wear, is usually automatically compensated by increased pump speed. Calculations show that in case check valve wear results in an assumed flow loss of 20%, the associated power loss is 500 kW per hour, considering a flow rate of 300 m³/h and a pressure of 10 MPa. Based on a rate of 0.07 USD per kilowatt-hour, this equals 840 USD per day.

5. CircoCal ™– pushing energy efficiency to its limit in circulating fluid bed calcination

SPEAKER: Michael Missalla, Vice President Light Metals/Fluidized Beds business line at Outotec .

Increasing energy costs were the main reason for the invention of Outotec's Circulating Fluid Bed (CFB) Calcination technology in the 1960ies and ever since remained one of the main drivers for its improvements. With Outotec's latest CircoCal™ concept this demand is now addressed to its next level. But also other operating cost factors and product quality aspects are addressed. The measures and main characteristics of the CircoCal™ concept will be described and discussed as well as the cost impact on operation and investment. However any trial to get closer and closer to the theoretical minimum of energy consumption does come to the price of increased complexity of the process. Outotec has included in their developments many mitigation measures to maintain and even improve ease of Operation. In some upgrades parts of the CircoCal™ features have been already installed in industrial production calciners and will be presented and discussed in the present paper. Since the installation of CircoCal™ in the recent upgrade of AOS the thermal energy efficiency of the CFB calcination process can be pushed to more than 90% with energy consumptions less than 2.7 GJ/t.

6. Changing the energy matrix in Alunorte

SPEAKER: Felipe Picanço, Power House Manager of Alunorte in Barcarena, Brazil

The energy source is a critical and decisive factor to an Alumina Plant, mainly as thermal basis. It may define how successful an Alumina plant can or not be. Alunorte started life as one of the best in global energy consumption and keeps this focus as a very important company value. In order to minimize the use of expensive fuel oil, Alunorte decided to use coal as the main fuel for power and steam production and also decided that this should be done with improvement on the overall environmental performance. This strategy effectively led to significant savings to the Company on top of reduced need of power purchasing from the national public network due to cogeneration feasibility.

7. Cost approach in daily management system

SPEAKER Eliane Allegrini, Refinery Business Advisor at Alumar in São Luis, Brazil

This paper describes the financial approach in use at ALUMAR Refinery to track daily production cost as part of Daily Management System – DMS, in place since 2006. The DMS is a key tool to manage plant performance through production and consumption factor indicators. The daily approach is important to avoid surprises, to quickly initiate problem solving and to keep the culture of a learning organization. However, this tool traditionally shows the main performance indicators with no

connection to financial impact. So an excel spreadsheet was implemented by controllership and technical department to turn the operational performance into financial impacts. The main benefits achieved so far are the support for operational decisions based on financial impacts, market trends, and commitments related to day-by-day strategy towards forecast results accuracy.

8. Break point studies: Effect of bauxite quality

SPEAKER: Sankar Sankaranarayanan, Vice President and Head of Hindalco Innovation Centre – Alumina at Belgaum, India

Efficient process design of alumina refineries results in achieving the highest possible alumina concentration in the liquor or in other words, achieving the maximum A/C ratio in the liquor after bauxite digestion. Detailed laboratory evaluation of bauxite is normally required to arrive at the optimum conditions. Since this is a very involved process requiring a lot of time and money, for preliminary estimation purposes, the A/C ratio values are often assumed and calculations are made accordingly. This study attempts to propose methods to estimate this A/C ratio values based on the quality characteristics of relevant bauxite instead of the need to 'assume' this value. Tests are done with different bauxites and the effect of bauxite quality characteristics on Break Point A/C ratio is evaluated.

9. Alumina extraction versus size distribution of ground bauxite

SPEAKER: Caio Moreira van Deursen, Senior Mining Engineer at Votorantim Metais from Brazil

Rondon do Pará bauxite has gibbsite as the available alumina carrier on the low temperature Bayer process. For the digestion of gibbsite to occur, temperatures ranging between 135 to 150°C are necessary. To verify the influence of the particle size on the extraction kinetics of alumina, digestion tests in different size fractions and distributions were done. That made it possible to observe the relation between particle sizes versus alumina extraction. The study indicates that there is an optimum size range for digestion. It also indicates that fine particles interfere on the coarse particles extraction.

10. Rio Tinto Alcan journey in solid/liquid separation

SPEAKER: Antonio Pucci, Acting Director Refinery Technology Sales at Rio Tinto Alcan

Rio Tinto Alcan's leadership in this field traces its origins to the late 70's when various red mud disposal sites were constrained and opportunities to increase their footprints were limited. Through the years, Rio Tinto Alcan High Rate Decanters and Deep Cone Thickeners have become industry's benchmark and have found their way in numerous refineries as well as base metal ore processing plants worldwide. The turn of the 21st century saw the emergence of the need to achieve even higher efficiencies with constrained capital. Rio Tinto Alcan laboratories have pioneered a new group of technologies including some that enable the retrofit of thickeners to reach ever rising solids content as well as improved flowability. This paper will discuss Rio Tinto Alcan latest patented technologies in this field as well as present Rio Tinto Alcan unique solid / liquid separation laboratory capabilities in Canada.

11. Performance evaluation of CYFLOCTM ULTRA 5300 – A new HXPAM red mud flocculant applied in CBA (Companhia Brasileira de Aluminio)

SPEAKER: Renata Vinhas de Oliveira, Alumina Applications Engineer at CYTEC Industries Inc.

CYFLOC^{TM} ULTRA HX-5300 Flocculant is a hydroxamate-based polymer developed for application in the clarification stage of Alumina plants. Hydroxamated polyacrylamide has over many years demonstrated to be an effective flocculant with respect to improving overflow clarity and underflow density of red mud in Bayer process solid-liquid separations. The application of CYFLOC^{TM} ULTRA HX-5300 has demonstrated that it is possible to control the settler stage with a dose reduction of approximately 20% in comparison to CYFLOC^{TM} HX-3000. This paper presents the results of the plant trial of CYFLOC^{TM} ULTRA HX-5300 conducted at CBA (Companhia Brasileira de Alumino). Results

indicate that by applying CYFLOC^{TM} ULTRA HX-5300 it is possible to modify the bauxite feed ratio, allowing a higher ratio of a difficult-to-settle, silica rich, bauxite to be processed at a reduced flocculant dosage.

12. The effect of additives on gibbsite auto-precipitation and bauxite residue flocculation when processing goethitic bauxites

SPEAKER: Desmond Lawson, Bayer Consultant at Windalco a company that is managed by UC Rusal Alumina Jamaica Ltd.

Many alumina refineries experience premature alumina precipitation (commonly referred to as gibbsite auto-precipitation or gibbsite reversion) in the mud circuit unit operation. Gibbsite auto-precipitation has been investigated under simulated mud washing conditions (typical to a Jamaican Bayer Refinery) using several additives. Sodium gluconate (gluconate) was found to be the most effective additive, stabilising both synthetic and real liquors for up to 24 hours at a solution concentration of 5 mmol L^{-1} and red mud loading of 50 gL^{-1}. For an additive to be considered effective at mitigating gibbsite auto-precipitation it is important to consider the impact it may have on other unit operations such as residue flocculation and gibbsite precipitation. Residue flocculation tests indicated that gluconate behaviour is complex, negatively affecting floc aggregate formation and supernatant clarity at low applied concentrations ($< \sim 0.25$ mmol L^{-1}) and facilitating floc aggregate formation at high applied concentrations ($> \sim 0.25$ mmol L^{-1}), with supernatant clarity remaining poor. The effect of gluconate concentration on the seeded precipitation of gibbsite from pregnant Bayer liquors was found to be significant even at very low applied gluconate concentrations (< 1 mmol L^{-1}), suppressing secondary nucleation and retarding the rate of agglomeration.

13. Utilizing Nalco RRA polymer technology to improve the red mud clarification process at CBA alumina plant in Brazil

SPEAKER: Carl Anthony Lawson, Industry Technical Consultant ,Nalco Latin America

Maintaining an optimum mud balance and throughput in the CCD mud circuit at CBA is critical to the efficiency of mud filtration rate and ultimately in achieving the plant production goals. This is a major challenge because of the ever-changing bauxite quality due to the constant requirement of blending different bauxites ore types. Flocculant selection and application is a major part of the process management strategy to maintain operational security and avoid production bottlenecks in the CCD mud circuit. This paper highlights the process of selection, laboratory testing and plant evaluation of a new technology generation of red mud polymers designed to provide a broad scheme of process advantages at polymer dosages lower than conventional red mud flocculants. The plant implementation of the Nalco Rigid Rod flocculant program is currently providing the value /benefits observed from laboratory tests and the previous plant trial. The Nalco program being utilized is 85232 RRA, which is a broad, based high anionic, high molecular weight synthetic polymer designed to provide higher underflow solids in the thickeners and washers of the bauxite red mud circuit. CBA is able to use lower flocculant dosages to achieve optimum solids/liquid separation and mud thickening throughout the clarification circuit while maintaining the required control of mud bed level and liquor overflow clarities. CBA implementation of the RRA polymer program and best practices to achieve and maintain the highest level of value/benefits is supplementing the plant operating procedures in clarification, resulting in significant overall reduction in the cost of operation.

14. Study of filter aid recovery from Bayer process

SPEAKER: Lucélia Moraes, Process Engineer at Alunorte in Barcarena, Brazil

Lime is one of the main raw materials of the Bayer process. The direct reaction of lime with liquor carried out under appropriate conditions results in the formation of a highly stable calcium aluminate crystal called TCA (Tricalcium aluminate), which is useful as a filter aid in the polishing filtration of the pregnant liquor. A cake is formed by the deposition of red mud and TCA during the filter operation, which is discarded at the end of filtration cycle and becomes a waste of process. The aim of this work was to evaluate an alternative of recovering the TCA from the filter cake disposed at Hydro

Alunorte production lines 1, 2 and 3. Mass balances, separation tests of the mud present in the cake filtration, physicochemical characterization of the recovered material, evaluation of the cake specific resistance to filtration and economic evaluation of the potential benefits of the proposal were done. Results showed that particle size classification was sufficient to separate red mud from TCA contained in the cake. Decrease was observed in filtration specific resistance with the addition of recovered TCA. Possible gains on process and operational safety were also identified.

15. Precipitation control upgrade at Votorantim Metais - CBA's alumina refinery

SPEAKER: Daniel Cavichioli, Process Manager at Votorantim Metais / CBA from Brazil

Between 2006 and 2007 the process team of Votorantim Metais/CBA's alumina refinery developed a simulation of the precipitation stage of the Bayer Process. This simulation is based on mathematical modeling of the process parameters. The target of this simulation is stabilizing the process control. This precipitation model was successful and became the main tool of controlling the precipitation stage. The current pressure to reduce aluminum production costs required an optimization of the simulation model, to achieve better levels of quality and productivity. This paper discusses the upgrade of the mathematical model. It includes statistical tools to validate the input data, correlations for the prediction of crystal strength and the mass balance in the hydrate classification stage. The optimization of the model increased the reliability of process control; it ensures the operation close to its maximum efficiency, while it keeps the product quality.

16. Towards plug flow in a vertical agitated tank

SPEAKER: Detlef Klatt, Owner and Managing Director of STC-Engineering from Germany.

This paper reviews current design and process aspects on continuous process operation for some applications in the hydrometallurgy field. Control of residence time distribution and avoiding back mixing often requires a larger number of continuous stirred tanks in a row, which is quite costly with respect to investment and operation. A classical undispersed plug flow reactor however is often not the solution, as required mass transfer cannot be achieved. Focus is put onto a dispersed plug flow reactor, where the impeller flow avoids back mixing, but creates mixing chambers by arranging virtual baffle plates. Thinkable applications could be, but not limited to, digesters for alumina extraction from bauxite or aging reactors for alumina suspensions. Height by diameter ratio can range up to 6 operational volume up to 200 m³ parted into up to 20 virtual chambers.

17. Alumina recovery estimation trough material balance in Alumar refinery

SPEAKER: François Santana, Refinery Process Supervisor at Alumar in São Luis, Brazil

The Bayer process is well known as the most profitable way to produce alumina on an industrial scale. Lasting more than 120 years since its invention, a lot of space for performance improvements still remains. One of the main performance metrics is alumina recovery, which means the bauxite's alumina fraction that was converted to production. The importance is related to plant sustainability since it is directly associated with red mud generation and bauxite consumption, and has strong indirect relations to soda, energy and flocculants consumption. Daily alumina recovery management was a big challenge due to the unavailability of direct measurement, low accuracy of available alumina analysis in residue and impracticality of physical measurements. The aim of this work was to develop daily alumina recovery estimation through plant material balance, and suggest its use as a lagging indicator for plant alumina recovery. After adjustments on residue sample and analysis routines, the estimated values reconciled satisfactorily with monthly inventory, presenting deviation lower than 1%, and daily figures show it to be in accordance with plant performance variation, enabling the use of this approach as a measure of effectiveness of the actions taken to keep recovery under control.

18. The Orbite process: an integrated acid-based technology for extracting alumina from clay and alternative feedstock

SPEAKER: Marie-Maxime Gilbert, Process Engineer at Orbite Aluminae Inc. from Canada

Orbite Aluminae Inc. owns the mining rights to the Grande-Vallée property, the strategically located 6,441-hectare site of a homogenous aluminous clay deposit in the Gaspé area of Québec, Canada. In a single sector of its property, Orbite has identified an Indicated Resource (in compliance with Canadian National Instrument 43-101) of one billion tonnes of aluminous clay containing as Indicated Resources Al_2O_3, SiO_2, Fe_2O_3, MgO, along with, as Inferred Resources rare metals and rare earths. The truly groundbreaking factor in this story is Orbite's unique and low-cost patented technology, which enables the extraction of alumina and other valuable and marketable by-products from a variety of sources, including aluminous clay, bauxite, kaolin, nepheline and other aluminum-containing ores. What's more, the company's continuous process does not generate the infamous and caustic "red mud" associated with the long-established Bayer process for extracting alumina from bauxite. This red mud typically requires long-term storage to protect the environment and human life. By contrast, Orbite's process separates the individual components of the clay sequentially and recycles the acid used to leach out the metals. The company has assembled a consultative committee in the Gaspé region to inform local communities on the project's ongoing status and to gain their input on the region's key challenges and needs.

19. Comparison of acidic and alkaline technologies for producing alumina from low grade ores

SPEAKER: Dr. Andrey Panov, Head of the Alumina Engineering and Technology Directorate of UC RUSAL's Engineering and Technology Centre (VAMI) in St. Petersburg, Russia..

Impairing the quality of mined bauxite with increasing price and reduced availability, long distance between large bauxite deposits and inland aluminum metal producing regions leading to high transport costs of bauxite and alumina again put on the agenda elaboration of technology for efficient processing of domestic low-grade aluminous ores that are close to major aluminum industry locations. The researches on acid methods for producing alumina were actively done, starting from 20-ies of the last century and only few of them were commercially implemented for some time. But the overall level of technology did not allow them to compete over Bayer and sintering alkaline methods. At the present time as the new corrosion resistant materials and hardware solutions becoming increasingly more available that allows re-evaluating the results of previous works in terms of improvement and implementation. The paper examines the state of the problem to produce alumina by the hydrochemical acidic methods showing their advantages and disadvantages vs commercially established alkaline Bayer and sintering technologies.

20. Red mud dewatering options

SPEAKER: Quentin Avery, Global Sr. Product Manager for Filter Press Technologies at FLSmidth

Red mud residue management has been a consistent issue for review within alumina refinery operations. With 1-2.5 tons of red mud residue per ton of Al_2O_3 produced, consideration of the various options must be carefully undertaken. Common practice 60-70 years ago was to dump residue slurry directly to rivers, swamps, oceans, etc. No longer an acceptable & environmentally-sound solution for most refineries, alternative approaches were developed worldwide including mud lakes; wet impoundment areas engineered to hold the large quantities of slurry. Red mud underflow slurry from the final stage washer can be 'dry-stacked' for evaporative dewatering in a residue disposal area. Slurries for dry stacking can be pumped directly from washer underflow *or* dewatered first, typically utilizing rotary drum vacuum filters, thereby increasing solids concentration in the material to be stacked. An alternative approach is to even further dewater red mud slurries with pressure filters for "dry-storage" of the resulting high-solids filter cakes. Automated conveying and stacking equipment become key components in system designs for dry storage. This paper will detail the various flow-sheets and equipment for red mud disposal and discuss the selection criteria for an alumina refinery.

21. Enabling economical dry stacking of bauxite residue by efficient deliquoring and washing with a membrane filter press

SPEAKER: Antti Häkkinen, Professor at the Lappeenranta University of Technology in Finland

The preferred technique for disposal of bauxite residue, when considering the environmental issues together with the possible future utilization of the solids, is dry stacking. In order to perform the dry stacking in an economical way, the deliquoring of the residue must be carried out efficiently and it is also important to wash the obtained solids well to minimize the amount of soluble soda within the solids. The study presented in this paper aimed at detecting the most important variables influencing the deliquoring and washing of bauxite residue performed with a membrane filter press and at determining the optimal operating conditions resulting in the desired overall results. The results obtained from the pilot-scale experiments were evaluated by considering the properties of the solids, the consumption of wash liquid as well as the overall heat and energy balances. Several variables were included in the experiments which were performed according to the fractional factorial design. Two different cake washing techniques were also used and their performances were compared. The results clearly reveal the importance of operating variables on the success of the deliquoring/washing process and it is also shown that the process can be optimized by careful analysis of the experimental results.

22. High efficiency and design optimization in red mud filtration with automatic filter press

SPEAKER: Andrew Hawkey, Manager at Diemme Filtration (Asia Pacific Region), Melbourne, Australia

Diemme Filtration since many years is specialized in the design and manufacturing of solid-liquid separation filter presses employed in a wide range of industrial sectors. Especially in the mining sector, where the working conditions are very hard (heavy duty), it is necessary to design and customize machines down to the smallest details. In this sense, the Red Mud case is particularly significant also by reason of the environmental themes linked with the dewatered material storage. In order to satisfy all these requirements DIEMME Filtration developed a project method which has its strength in the team work. This work reports the results of a research study aimed at analysing the behaviour of the sludge within the filter press during all the filtration stages. In this work will be reported a compared analysis of the industrial scale experimentation carried out on several industrial red mud filtration cases through filter press. Besides this, it will be shown how filter presses can optimize and reduce the environmental impact of dewatered red mud thanks to the low residual moisture and soda content referring to a concrete case history: filter press GHT 1500 installed at Mal Magyar Aluminium Plant in Ajka, Hungary.

23. Dry storage technology - Strength and pore pressure development and compactability of tailings

SPEAKER: Kellen Nery, Geotechnical Engineer, Pimenta de Avila Consultoria, Brazil

This paper presents a discussion on the compactability of filtered residue and on the results of geotechnical tests on compacted filtered residue. In order to study the embankment resulted from the compacted residue, laboratory tests were performed to compact the residue and to study the pore pressure development in several states of moisture content, up to 4% above optimum of standard Proctor. The results are used to estimate the stability of an embankment that can be constructed with the filtered residue, compacted in layers, as a normal earth dam embankment. So the design of the disposal of the residue volume can be addressed in terms of an embankment end of construction case.

24. Disposal of fly ash with bauxite residue (red mud) – Studies on leaching, flow and hardening behavior

SPEAKER: Sankar Sankaranarayanan, Vice President and Head of Hindalco Innovation Centre – Alumina at Belgaum, India

The mega alumina refineries generate bauxite residue of the order of 1-3 million tonnes annually. In many of these refineries, coal-fired boilers are part of the set up for generating steam and electricity. Hence, huge quantities of fly ash are also generated at these refineries which need to be disposed-off in an environmentally safe manner. One option for this is to dispose-off fly ash along with the bauxite residue. Fly ash might contain harmful components depending on the source of coal. It is essential to study the leaching behaviour of these components in alkaline liquor. The flow and hardening behaviour of the bauxite residue – fly ash mix also need to be evaluated for ensuring proper design of the overall disposal system. This paper describes one such study done for a mega refinery in Africa. Only sulphate was found to get leached out from the fly ash in significant amounts. As solids content increases, flow is adversely affected and hardening becomes faster. Addition of fly ash increases flow compared to only bauxite residue at equivalent solids content levels.

25. Bauxite residue remediation and carbon sequestration from flue gas

SPEAKER: Luis Venancio who is completing a PhD at PRODERNA, the Amazon Natural Resources Engineering Development Program at the Federal University of Pará, Brazil

The production of alumina from bauxite using the Bayer process generates 0.7 to 2.0 ton of residue, known as red mud, and an average of 1005 kg of CO_2 per ton of alumina produced. The direct use of exhaust gases to react and neutralize the bauxite residue may allow a double gain: open a wide range of new applications for bauxite residue, reducing its reactivity and sequester from 26 to 134 kg of CO_2 per ton of alumina. This paper shows a pilot scale reaction of a suspension of bauxite residue in water with flue gas, produced from direct oil burning, similar to the exhaust gases of a refinery. Three different types of reactors are used, a spray tower and two packed columns with random and structured fillings. The inlet and exhaust gases are analyzed using electrochemical cells and non dispersive infrared sensors. The pH of the suspension is monitored during and after the reaction to evaluate the buffer effect.

26. Monitoring vegetation and soil development on bauxite residue sand

SPEAKER: Mark Dobrowolski, Assistant Professor (Research), University of Western Australia

Vegetation has been established for more than 20 years on residue sand (> 150 μm) covering residue storage areas in Western Australia. Gypsum incorporation, wood chip mulching and fertilizer application preceded revegetation with native species by seeding and transplanting. Minor irrigation sometimes occurred in summer. Rehabilitation was evaluated at 81 sites of different age. On 6 × 6 m plots, the height, areal cover and species diversity of vegetation were recorded and samples of foliage and soil at various depths were collected for chemical analysis. The data were examined by quantile regression for possible limitations to long-term success of rehabilitation. Salinity and sodicity deeper in the soil profile probably limit vegetation growth to some extent even after 10 years of residue weathering and 800 mm average annual (mostly winter) rainfall. Deficiency of Mg, K, Zn and Mn may develop without supplementation. Managed grass accumulates carbon equal to that under indigenous scrubland. The study provides a baseline in terms of which the development and sustainability of soil quality, and the health and diversity of the constructed ecosystem, can be evaluated by regular monitoring at each site. This could provide, prior to termination of alumina production, the evidence needed for closure.

27. Transforming bauxite residue mud into soil for rehabilitation

SPEAKER: Martin Fey, Professorial Fellow, University of Western Australia

Long-term rehabilitation of residue continues to be a challenge at alumina refineries. Natural soil with which to build a cover for revegetation may be scarce and costly, and the properties of red mud make conversion into soil extremely difficult. Decausticisation can be achieved with amendments which neutralise sodium aluminate, creating a tolerable pH but producing sodium salts not easily removed by leaching unless permeability is greatly improved. Drying and cracking can enhance infiltration of water but desalination is not feasible without improved porosity, under-drainage and a final destination for salts. To achieve these requirements local circumstances are important. In Western Australia the Mediterranean climate, ocean proximity and availability of suitable chemicals influenced our proposal of the following strategy: during summer, thickened residue mud is amended with seawater bitterns, phosphogypsum, inorganic fertilizer, soil inoculum and a small quantity (3 Lm^{-3}) of hydrogen peroxide, before being poured as a thin layer to dry. The porous, saline residue is piled into beds above drains, irrigated and planted with grass. Saline drainage is collected for disposal. The procedure has been successfully tested on a laboratory scale and field trials are being planned. Winter rain and biological activity should finish off the soil building process.

28. Closure plan of an alumina residue deposit – case study of Alunorte deposit

SPEAKER**:** Joaquim Pimenta de Ávila, consultant in civil and geotechnical engineering and president of Pimenta de Avila Consultoria from Belo Horizonte in Brazil

The solid waste deposit, as implemented in the production of alumina industries are essential structures for containment of the red mud, but with limited useful life. This factor, associate with growing environmental awareness and legal requirement, has encouraged entrepreneurs to conduct studies on the future destination of these areas. Therefore, an effort has been materializing, leading companies to develop their closure plans in advance to the final useful life, making the waste deposit are able to offer long-term full conditions of public health and safety, and provide a useful environment and harmonious of the local landscape.
The article presents a case study on the closure plan developed for the Red Mud Diposal Site at Alunorte, located in Barcarena, Para State, Brazil. Will be addressed in this paper the main aspects considered for the geotechnical design of the cover system, including: landscape restoration, subsurface drainage, impervious layer, surface drainage and revegetation. The cover system proposed is intended to prevent contact the rainwater with the waste deposited and with the water released by settlement will occur over time.

29. Mineralogy and chemistry of red mud from Bayer-processed Amazon bauxites

SPEAKER: Marcondes Lima da Costa, geologist and professor at the Federal University of Pará, Brazil

Red mud, a residue of mineral processing, is generated on a large scale in the Amazon region, responsible for more than 60 % of the bulk Brazil production. It is disposed in tailings ponds by means of the dry-stacking method. Red mud is characterized by its red color and silt grain size, and is constituted of hematite, goethite, sodalite, kaolinite and anatase, which account for the high content of Fe_2O_3, Al_2O_3, SiO_2, Na_2O, TiO_2 and CaO. CaO and Na_2O reflect incorporation during the Bayer process, while the other oxides are a legacy of bauxite. When the chemical composition is normalized with the Trombetas bauxite ore, it is possible to confirm the residual nature of Fe, Si, Ti and of most trace elements, including REE, the constituents of the accessory minerals of bauxite, such as zircon and anatase. Cu and Pb, partitioned between liquor and red mud, can be recovered during the refining of alumina. The chemical and mineralogical composition of red mud is therefore strongly controlled by bauxite and by the Bayer process.

30. Physical-chemical characterization of Venezuelan bauxite residues – Valorization options

SPEAKER: Brenda Omaña Sanz, geochemist in the geo-Environment team of the Civil Engineering and Geo-Environment Laboratory of the University of Lille, France.

Venezuela contributes to the alumina industry of South America with the production of more than 1 million ton of alumina per year (CVG Bauxilum). This industry has generated more than 15 million m^3 of bauxite residues. Unfortunately, these residues have not been yet studied, notably about their possible utilization. In this work, a physical-chemical characterization of dry Venezuelan bauxite residue was carried out by analyses of the particle size, the chemical and mineralogical composition and their surface area. Furthermore, chemical association and leachability of some heavy metals, REE and radionuclides contents within the residue were also studied by a sequential extraction method. Additionally, the radiation activity of radionuclides was analyzed by gamma spectroscopy. According to results of sequential extraction, most of heavy metals were associated with Fe-Al oxyhydroxide phases. Thus, the risk of release of heavy metals under natural conditions appears limited. The analyzed residue has a relatively high content in Th, U, and lanthanides; hence the extraction of these elements would be suitable. These results have shown the potential use of Venezuelan bauxite residue in key areas such as remediation of polluted systems (as amendment or sorbent agent) and in the recovery of minor metals.

31. Remediation of red mud using an innovative approach

SPEAKER: Marie-Maxime Gilbert, Process Engineer at Orbite Aluminae Inc. from Canada

Orbite Aluminae Inc. has developed a unique and low-cost patented technology, which enables the extraction of alumina and other valuable and marketable by-products from a variety of sources, including aluminous clay, bauxite (high-grade and low-grade), kaolin, nepheline and other aluminum-containing ores. What's more, the company's continuous process does not generate the infamous and caustic "red mud" associated with the long-established Bayer process for extracting alumina from bauxite. This red mud typically requires long-term storage in holding ponds to protect the environment and human life. Orbite's technology that conforms to the highest standards of sustainability has recently been successfully tested on red mud to separate sequentially its individual components and to recycle the acid used to leach out the metals. These results demonstrate that Orbite's innovative and economical technology is not only the alternative for alumina production from a variety of aluminous ores without generating red mud but also to remediate the existing red mud toxic residues that represent and environmental liability for the alumina and aluminum industries.

32. Extraction of titanium compounds from Bayer process residue

SPEAKER: Luis Venancio who is completing a PhD at PRODERNA, the Amazon Natural Resources Engineering Development Program at the Federal University of Pará, Brazil

The analysis of the Bayer process residue shows the presence of chemicals compounds and minerals with considerable economic value. Among these are titanium oxides at concentrations above 5% by weight. This paper shows experimental methods for the extraction of titanium through the process of calcination at 900°C followed by acid leaching with concentration of H2SO4 at 20% and 30% v/v at 60°C, 80°C and 90°C. During the leaching process, there was intense extraction of iron compounds, resulting in an increased concentration of titanium at the red mud. This was found in all experiments, especially those which were performed at 90°C and H2SO4 at 30% v/v, where there was a concentration of up to 14% titanium considering the global mass balance. From the data obtained, the red mud material becomes interesting to be used as an alternative source of titanium minerals, which are found in nature with a percentage of around 8%.

33. Direct reduced iron (DRI) from red mud - A green technology

SPEAKER: Dr. Bhagyadhar Bhoi, Senior Principal Scientist at the Institute of Minerals and Materials Technology, Bhubaneswar, Odisha, India

Red Mud of Indian origin contains around 50% plus of Fe_2O_3 depending on the source of bauxite and is considered as a hazardous waste for the Alumina Industry. For production of one tonne of Alumina employing the time tested Bayer's Process, around two tonnes of Red Mud is generated from three tonnes of Bauxite. Though efforts are on throughout the world to find out suitable avenues for bulk utilization of Red Mud, no suitable solution has so far emerged. Institute of Minerals and Materials Technology, Bhubaneswar have developed a green technology for production of Direct Reduced Iron (DRI) from Red Mud in laboratory scale by using Microwave Hydrogen Plasma Reactor. The process is eco-friendly and carbonless and free from CO/CO_2 emissions. Instead, steam [H_2O (g)] produced from the Microwave Hydrogen Plasma Reactor as a by-product is obtained and recycled in the process. This steam has a scope for utilization in the field of electric power generation when the process is implemented at commercial scale. The process parameters like temperature, pressure, gas flow and microwave power have been studied and optimized. The kinetics of reduction of iron has also been studied. The process has novelty and uniqueness in character.

34. Red mud sulfuric acid neutralization: Elaboration of process routes to return sodium and alumina into Bayer process

SPEAKER: Dr Andrey Panov, Head of the Alumina Engineering and Technology Directorate of UC RUSAL's Engineering and Technology Centre (VAMI) in St. Petersburg, Russia..

The main obstacles to the utilization of red mud – waste of alumina production, are the presence of chemically bound caustic and high humidity, which negatively affects their consumer properties, limiting the application, but also prevents the potential transportation by railway. Therefore, the main objective to create conditions for the successful utilization of the mud is caustic soda neutralization with return of caustic and partially alumina into Bayer process or creation of other commercial products. The key elements of the flow diagram for red mud neutralization with sulfuric acid have been elaborated in a laboratory scale to produce iron-containing low-caustic product suitable for use in the steel and cement industries and the possibility of obtaining from acidic solutions the sodium-aluminium sulfates.

35. Influence of the addition of red mud from Bayer process in polymer matrixes of isophthalic polyester.

SPEAKER: Mauro Oliveira, Researcher at INPAR Industrial from Brazil.

This paper presents a study of bauxite residue addition to isophthalic polyester matrices, looking for its utilization in the production of dividing plates for civil and marine construction, with reinforcement of vegetable fibers. For this application, the addition of bauxite residue to the polymer matrix is made as 2%, 6%, 10%, 20% and 50% of bauxite residue in relation to the polyester mass. The goal is to evaluate its mechanical properties, using standard ASTM: 790M-86 (flexibility properties) and D638-90(tensile properties), and to determine the average density in relation to the bauxite residue percentage variation. From the obtained results it was concluded that it is possible to use bauxite residue as filler in isophthalic polyester.

36. Potential of bauxite residue in developing innovative materials for engineering application

SPEAKER: Dr. Mohini Saxena, former Scientist at the Advanced Materials and Processes Research Institute, CSIR, India.

Bauxite residue, commonly called red mud is the main by-product of making alumina by the Bayer process. A considerable research has been done on the utilization of red mud as a raw material for production of a range of products. It can be used as a construction/building material in bricks, blocks,

light weight aggregates, in cement and concrete industry. Bauxite residues can be used for soil remediation, as geo polymers and as a clay material, construction of dykes and as ceramic/refractory product. In iron and steel industry it can be used for recovery of iron and titanium. In environmental field, it can be utilized in pollution control as adsorbent for cleaning of industrial gases, as synthetic coagulants in waste water treatment and as a catalyst especially for coal hydrogenation. Red mud can as well be used in paints and pigments. The present paper describes details on value added products developed with bauxite residue polymer composites reinforced with vegetative fibres. It is found to be a versatile innovative material for its application in doors, partitions, flooring tiles, furniture, instant houses and other similar mouldable products.

ALUMINIUM PROGRAM

1. Achieving low greenhouse gases emission with DUBAL's high amperage cell technology

SPEAKER: Abdalla Al Zarouni, Senior Manager Technology Development, Dubai Aluminium ("DUBAL")

DUBAL has grown from 90 000 tonnes per year capacity in 1979 to over one million tonnes in 2010, predominantly using its in-house developed technology which now ranks on par with the leading high amperage and high current density cells. Although the original DUBAL smelter was built in an isolated area, the urban growth of Dubai placed it in the centre of a thriving business and residential community. In its growth, DUBAL adopted environmental protection as one of its priorities. This included the reduction of fluoride and GHG emissions. The perfluorocarbons (PFC) gases, generated by anode effects, have traditionally been a large contributor to the CO_2 equivalent footprint of smelting cells. A better theoretical understanding of anode effect initiation, more advanced control logic of alumina feeding and innovative signal processing, developed at DUBAL, have led to dramatic reduction of anode effect frequency and duration. World benchmark standards have been achieved by integrating the control system with the advanced design features of the DX and DX+ cells. Compared to an industry average of PFC emissions at 590 kg CO_2 equivalent/tonne Al in 2010, DUBAL technology has demonstrated capability of operating sustainably below 10 kg CO_2 equivalent/tonne Al.

2. An update on AP-60 reduction technology

SPEAKER: Bernard Allais, Director for Technology Sales & Marketing - Smelter at Rio Tinto Alcan.

No abstract is available.

3. Development of the RA-300 and RA-400 pre-bake technologies for use at new aluminium smelters

SPEAKER: Victor Buzunov, Director Aluminium Technology and Technical Implementation at the Engineering & Technological Center of United Company RUSAL

Given the tight competition in the world, Al smelters should have high production indexes. They are not possible if there is no advanced technological base. In 2002, RUSAL started working on its own high-amperage reduction technology. As the result, RUSAL has become technologically independent and has earned the opportunity to build new smelters as well as to offer competitive products in the market. This paper provides information on the main stages of development of the RA-300 & RA-400 high-amperage technologies, including information on design concept, testing period, and industrial application of the technologies.

4. EMAL's success start up, steady, stable and fast

SPEAKER: Abdulla Alriyami, Potline Superintendent at Emirates Aluminium (EMAL)

EMAL "Emirates Aluminium" was established in 2007, as a joint venture between DUBAL "Dubai Aluminium Company" and MUBADALA "Mubadala Development Company". EMAL's phase I consists of 2 Potlines with 756 pots using the Dubal DX Technology. The challenge was to commission, prepare, preheat and start the pot in shorter period without allowing early pot failure. In addition, more than 50% of employees were just new in this field. The first pot bath-up was achieved on the 2nd of December 2009, coinciding with a very important day for the UAE, the day the country celebrates the unity: UAE national day. On the 2nd of January 2011 the last pot was bathed-up. EMAL has completed the start-up of its phase I Potlines in 13 months without any pot failure, and this was achieved due to a well-planned strategy and highly trained and dedicated team that worked in harmony from the start-up stage into the current steady operations.

5. An integrated approach for the brownfield debottlenecking of primary aluminum smelters

SPEAKER: Hugues Tremblay, Director Light Metals Group at Hatch, Canada

While Brownfield expansions and amperage creep programs are usually more cost-effective than Greenfield projects, the technical challenges involved are typically more demanding. Production increase efforts have implications on all plant activities and require capital investment that is not directly proportional to the capacity increase. The maximum return on investment is therefore not necessarily the maximum achievable potline current. In an organic growth scenario, it is necessary to assess the impact of increased throughput on every major sector such as substation, carbon plant, reduction and casthouse to effectively identify potential process bottlenecks. Furthermore, peripheral and auxiliary systems should not be ignored when planning amperage creep programs. This article introduces an integrated approach for the Brownfield debottlenecking of smelters, presents advanced methods to assess the performance of specific equipment and systems as well as discusses examples of successful implementation.

6. Production growth and future challenges in Aluminium Bahrain (Alba)

SPEAKER: Nabeel Al Jallabi, Acting Manager Reduction Services at Aluminium Bahrain

Aluminium Bahrain B.S.C. (Alba) consistently ranks as one of the largest and most modern Aluminium smelters in the world. Known for its technological strength and innovative policies, Alba enforces strict environmental guidelines, maintains high track record for safety, and is widely regarded as one of the top ten performers on a global scale. Commissioned in 1968 with a capacity of 68,000 tons per year, Aluminium Bahrain has steadily progressed and today is one of the world's top performing and largest Aluminium producers worldwide. Production output has increased stepwise since start-up through numerous improvement projects and several major expansions. The current plant capacity is close to 900,000 tons per year. The main strategy adopted by Aluminium Bahrain since the early days has been to sweat the assets by maximizing the production of the electrolytic cells with sustaining cost effectiveness position through different programs, maintaining lowest impact on the environments, developing nationals along the way aiming to zero injury as a core principle of the business. This paper describes the strategy adopted by Aluminium Bahrain highlighting the challenges encountered to achieve the key milestones along with the future plans.

7. D18+: Modernization of DUBAL's original potlines

SPEAKER: Abdalla Al Zarouni, Senior Manager Technology Development, Dubai Aluminium ("DUBAL")

Dubai Aluminium commenced operation in 1979 with 360 reduction cells in three pot lines and utilizing the D18 technology. This paper summarizes the extensive work done of Dubal team to revise and completely modernize the cell technology in these original pot lines.
Designated D18+, the new in-house design incorporates the latest cell technology – such as magnetic compensation and proper point feeders – within the existing footprint of the original D18 pot line infrastructure. The objectives behind modernizing the cells through new technology are to reduce the specific energy consumption to below 12.9 DC kWh/kg Al, reduce the anode effect frequency to below 0.10 /cell/day and allow for possible further amperage increase by 40 kA.
Seven D18+ cells were constructed and successfully started-up in March 2012; and are now meeting key design objectives. The test cells are currently being fully evaluated before implementing throughout DUBAL's D18 pot lines.

8. Value of integrated implementation of information and control systems in a greenfield smelter project

SPEAKER: Hugues Tremblay, Director Light Metals Group, Hatch, Canada

Construction of modern aluminium smelters, as well as associated upstream plants, is a complex endeavor, technically and organizationally. Moreover, shareholders are expecting quick ROI and full optimization of the capital expenditures invested during the project. In addition, when fully commissioned, these plants are facing significant operating cost pressures. One key approach used to manage this pressure are automation, production and business information systems to optimize processes, manage quality, prevent equipment damages, stream line supply chain processes, maximize human resources capability safely, focus on problems anticipation and generation of sound financial and cost control reporting. The application of advanced automation and production IT systems has grown tremendously in all aspects of the metal industry over the last 25 years and still grow rapidly. The metallurgical industry takes part as well of this trend, where computer based technology is now used to manage all aspects of industrial and business plant operations. As a result, this has led to a large increase in the number of systems available, in size and in complexity. The challenge aluminum plants are facing is to ensure the right technical integration and business alignment of these systems, and still be user-friendly and with low TCO (total cost of ownership). This presentation will explain why IT systems are critical for a large industrial plant and why proper integration can make the difference. The scope of IT assets to be implemented will be presented, then the list of challenges encountered in Greenfield project and what has to be done to fully integrate a modern aluminium plant, from shop floor instrumentation to the ERP, via an MES or other process control systems, will be described. A successful study case will be presented as a summary.

9. Development of the eco-friendly VSS technologies required for the modernization of aluminium smelters in Russia

SPEAKER: Victor Buzunov, Director Aluminium Technology and Technical Implementation at the Engineering & Technological Center of United Company RUSAL

The high cost the Krasnoyarsk and Bratsk aluminium smelters conversion (the capacity of each smelter is 1 million tonnes) to pre-bake technology has made UC RUSAL improve VSS technology. The development of Soderberg technology in Russia is aimed at reaching permissible emission levels. This paper has information on the results of the development of the colloidal anode, new gas removal system, new cathode design allowing low metal in the cell and the use of an automatic raw material feeding system.

10. Feed control for vertical stub Soderberg side break pots based on digital filters

SPEAKER: Nilton F. Nagem, Supervisor of Pot Rooms Process Control at Alumar in São Luis, Brazil

Sustainable aluminum production must reduce green house gas emissions (GHG) caused by anode effects. Decreasing anode effect frequency is only possible by improving Potroom operations and controls. A new feed control strategy was developed to improve alumina control on Vertical Stub Soderberg (VSS) Side Break pots in spite of their manual feed operations. The current alumina control for this kind of pot has been done manually for years, on a daily basis, with feed cycle frequencies that vary from 2 to 6 hours. Using pot volts and line amperage as inputs the new feed control algorithm uses digital filters to clean up the noise in those signals. The filtered outputs are an estimated electrical resistance, curvature and delta resistance, all used in conjunction with other operational criteria to determine the amount of alumina for the next feed cycle.

11. Shawinigan HS Soderberg potlines restart

SPEAKER: Claude Fradet Technical Director Electrolysis, Rio Tinto Alcan, Primary Metal, North America

On December 29, 2011, a long power failure caused by the explosion of a circuit breaker, and subsequent damages to connected equipments, forced the stoppage of two of the four potlines at the Shawinigan smelter. Each potline has 140 horizontal stubs end to end technology cells. The decision to restart the potlines was taken on February 6, 2012, and the restart was completed on the 27th of

April. This paper describes the event and the procedure for the preparation and the restart of the potlines.

12. Extended surface filters for smelter gas treatment centers (GTC) to increase capacity and allow higher temperatures

SPEAKER: Michael Neate, Technical Manager at Advancetex International, Australia

Extended surface filter technology has been used in aluminium smelters in Australia and Canada to increase the dust collection and fluoride scrubbing capacity of existing GTCs, which provides an alternative to major capital equipment upgrade and lowers the production cost per tonne of aluminium where GTC capacity limitations are restricting production. As production rates in the smelter increase with capacity creep, so too does the GTC operational temperature. While the proper application of extended surface filters can compensate for the reduced alumina adsorption efficiency at higher GTC operational temperatures, some smelters increased production demands are now pushing the GTC operation temperatures beyond the limits of the standard polyester filter media. Alternative traditional high temperature filter media is cost prohibitive, and this change in the Aluminium Smelting Industry has created a new cost/solution gap in the market of commercially available filter media. This paper summarises the success of the extended surface filters, and the development of a new and cost effective higher temperature filtration media, which when used in conjunction with extended surface filters will address both increasing GTC operational temperature, and the demand for greater capacity from existing GTCs without the need for costly capital equipment upgrades.

13. Gravity ventilation in potrooms a case study for greenfield and brownfield smelters

SPEAKER: Niek Menting , Sales Director at Colt International

For potrooms, it is essential to create a well designed ventilation system in order to remove the surplus of heat , (HF) gasses and/or dust .Cooling of the pots by fresh air intake is required to avoid overheating of pots and disturbing the smelting process. So there is a combined interest, either for health and/or for the process and simulations can help optimizing the ventilation and give a clear picture how the air moves in the building envelope. Simulations can predict the practical situation when the ventilation system is installed and in operation. For existing smelters, simulations can help to predict improvements in the ventilation system after increase of amperage and/or smelting capacity or when a shift is required from mechanical fans to gravity ventilators. Both the above simulations will be presented in an actual case study.

14. Segregation effects during transport and storage: New options for large storage units

SPEAKER: Arne Hilck, Product line Manager Silo and Alumina at Claudius Peters Projects
Projects

During pneumatic conveying and storage of alumina, the material should be treated very cautiously. High velocities during conveying can result in attrition of the product. Design of conveying and storage units can promote segregation into different material fractions and affect the quality of the product.
In this paper the general mechanisms of attrition during conveying are highlighted. The effect of segregation during filling and discharging of storage systems is described and countermeasures against segregation are shown. Storage systems using this Anti-Segregation-System (AS-System) and operational experiences with these are shown. The results are discussed.
A new simple design for easy modification of existing large storage silos is introduced using the AS-technology.

15. Gas-solid flow applications for powder handling in industrial processes operations

SPEAKER: Paulo Douglas Santos de Vasconcelos, Master project, process and maintenance engineer at Albras Alumínio Brasileiro

Gas-solid flow occurs in many industrial furnace processes. The majority of chemical engineering unit operations, such as drying, separation, adsorption, pneumatic conveying, fluidization and filtration involve gas-solid flow. Poor powder handling in an industrial furnace operation may result in a bad furnace performance, causing errors in the mass balance, erosion caused by particles impacts in the pipelines, attrition and elutriation of fines, overloading the bag houses. The lack of a good gas-solid flow rate measurement can cause economic and environmental problems due to airborne dust. The paper is focused on the applications of powder handling in relation with furnaces of the aluminum smelter processes such as anode baking furnace and electrolytic furnace (pot cell) to produce primary aluminum. The fundamentals of powder pneumatic conveying and fluidization will be discussed in this paper, such as the definition of a pneumatic conveying in dilute and dense phase, the fluidized bed regime map, and finally the air fluidized round airslide used to continuously feed alumina to the pot cells in the potrooms.

16. The Achilles heel of a smelter: Preventive maintenance of transport vehicles

SPEAKER: Stef Sep, General Manager, Hencon South Africa

Hencon started maintenance activities in the mid eighties in order to develop an preventive maintenance system for Vehicles. After 10 years of experience with running state of the art maintenance practices in Russia, India and Mozambique, in this paper we will show what we have learned. We discuss the importance of good communication between designers and maintenance experts and we will show a life example of how to support this communication in practice in order to offer high reliability at affordable budgets

17. Recycling materials thru rotary crushing and material separation in the aluminum smelter

SPEAKER: Brian Best, Account Manager at GPS Global Solutions from the United States

There are many areas in the aluminum smelter operation that can befit from efficient recycling of materials thru a low cost simple operation. DIDION has developed applications for rotary crushing and separation systems for recycling and recovery of materials. The continued development of the RT TUMBLERS has made mechanical processing of mixed materials a very cost effective and a low maintenance alternative to other processing systems. The equipment was originally designed for automotive foundry production applications where it was required to run 24 hours a day 7 days a week with minimal maintenance, making the RT Systems perfect for the primary aluminum smelters.
Current Applications of RT TUMBLER processing are:

- Simple method for separation metallics from oxides and salts in dross and salt cake processing, with a significant environmental impact in the reduction in landfill materials.
- Simple method for removal of carbon and bath from cast thimbles in the anode rodding shop saving consumables and floor space over traditional shot belts methods.
- Carbon Reclaimer and Cleaner, scrubbing the bath off used carbon blocks before crushing and recycling and then crushing to the required size in the same piece of equipment.
- Rotary Bath Crusher and size separator in a single process.

18. Statistical method to predict anode effect events

SPEAKER: Eliezer Batista, Technology Manager for Best Practices, Alcoa-Latin America

The Alcoa Global Primary Products group, by following a corporate vision, has set new environmental challenges over the next two decades. Alcoa has actively pursued greenhouse gas emissions reduction, for example one of the major objectives is to reduce CO2e by 20% in 2020. It is known that the anode

effect causes a huge change in pot resistance signal. We hypothesize that there is a disturbance to the individual anode voltage readings prior the anode effect occurrence. Our goal is to take advantage of having continuously available anode voltage readings in some Alcoa units to develop a reliable anode effect predictor and appropriate control reactions to eliminate this occurrence. We found three potential predictors for an anode effect by using the anode voltage readings. We created the Receiver Operating Characteristics (ROC) curves to compare the performance of all those potential predictors. The prediction is efficiently made 30 to 60 seconds prior an anode effect, but some events can be predicted up to 2 minutes before their occurrence. Additionally, by using principal component analysis (PCA), we identified that the prediction can be made efficiently with less than half of the anodes for P-225 pot. The computer control is able to take action every 10 seconds; therefore the prediction made 30 seconds before the anode effect is enough time to prevent it from happening. At that time, we can predict the anode effects with 60 to 80% of true positive events and just 2 to 10% of false positive events according to our simulation.

19. Measuring bath properties using the STARprobe

SPEAKER: Marc Dupuis, consultant at GeniSim Inc from Canada

Since the beginning of 2012, STAS is the world distributor of the STAR-Probe developed by Alcoa. Demonstration measurement campaigns have been conducted in different smelters around the world. During those campaigns, the STAR-Probe bath properties measurements have been compared with standard bath properties measurements regularly carried out in those smelters operated by different aluminium producers. Those independent comparative measurements all confirmed the capacity of the STAR-Probe to instantaneously and accurately measure Superheat, Temperature, Alumina concentration and bath Ratio for cell control purposes.

20. Implementation of STARprobe measurements & integrated pot control at Alumar

SPEAKER: Ari Silva, Process Engineering Consultant – Potrooms at Alumar in São Luis, Brazil

During last years Alcoa Technical Center has worked to develop a sensor able to measure thermal and chemical variables of electrolytic bath. After several years of researching and development STAR probe was delivered to Alcoa Smelters. STAR corresponds to the initials of the measurements given by this equipment, respectively Superheat, Temperature, Alumina and Ratio (excess of Aluminium Fluoride). STAR probe initially measures bath temperature and then the chemical composition is inferred based on the cooling curves of bath. Measurement data is transferred from the probe head to a tablet for processing data and final results are transferred to pot controller through a wireless connection.
Following other Alcoa smelters, Alumar has started the implementation STAR probe, initially to replace the sampling process and XRD analysis and later to add new features to the thermal control, through the introduction of IPC (Integrated pot control). This paper reports the first results at Alumar, after implementing STAR measurement in a group of pots.

21. Present progress in fast XRD analysis applying the Rietveld method for bath control

SPEAKER: Karsten Knorr, Global Market Manager for X-ray Mineralogy at Bruker AXS from Germany

Rietveld analysis emerged as a routine tool in quantitative phase analysis of crystalline powder samples. XRD data from solidified aluminium electrolytes can rapidly be obtained with a 1-dimensional silicon strip detector and analysed with the TOPAS software. It is shown how to calculate well established process control measures such as Bath ratio and excess AlF3 from the Rietveld results. These measures are widely used in aluminium production and are readily calculated with very high precision. The excellent agreement with Alcan reference data demonstrates the outstanding accuracy of the method. Furthermore, it is shown how to improve conventional Potflux analysis by the Rietveld method, taking into account the actual concentrations of the different Ca-Cryolite mixed

crystal. The extension of the method to Li or Mg containing bath and finally, the determination of X-ray amorphous material such as finely dispersed graphite is presented

22. Aluminas - New approaches to understanding smelter performance

SPEAKER: James Metson, Associate Director at the Light Metals Research Centre and Head of the School of Chemical Sciences at The University of Auckland in New Zealand.

The convergence of reduction cell technology for aluminium smelting technology into large prebake point fed cells has led to a similar convergence of requirements in terms of alumina properties. However despite considerable similarities in the properties and parameters reported on the specification sheet, there is still substantial and largely unexplained variation in observations of alumina performance in the reduction cell. This arises in part from the varied ways in which alumina is handled and processed, for example through dry scrubbers, but is also driven by alumina properties not effectively reported on the specification sheet. These are often associated with the amount and nature of fine particles. Impacts on bath chemistry, dissolution (AE frequency) and emissions are prominent amongst observation of alumina driven excursions in reduction cell performance. As many smelters increasingly are dependent on aluminas from a range of sources, a rethink of the way alumina properties are reported is timely in assisting smelters understand and better manage alumina performance.

23. Phase quantification of alumina using Rietveld-XRD analysis

SPEAKER: Frank Feret, Independent consultant at Feret Analytical Consulting from Canada

Application of X-ray diffraction to determination of alpha alumina (α-Al_2O_3) content in alumina has been one of the oldest methods of analysis in the aluminum industry. Rhombohedral aluminas may have a variety of morphological forms which cause marked differences in relative intensities of their major XRD reflections (the preferred orientation effect) when using the conventional X-ray diffraction. A dedicated Rietveld analytical program was built with structure data for 8 alumina mineralogical phases: alpha, beta (β-Al_2O_3 = $Na_2O{\cdot}11Al_2O_3$), delta, gamma (2), kappa, sigma and theta. The paper gives unique examples of phase quantification in aluminas of various origins and phase composition. The Rietveld approach was used to analyze several commercial ceramic aluminas, metallurgical aluminas, various reference materials and special grades of alumina. Application of Rietveld analysis to scrubber alumina and cover alumina characterization, in particular to determination of free alumina is also described.

24. Non-conventional structural analyses of anode backing furnaces to extend their life

SPEAKER: Urubatan de Souza Dias, Process and Refractory Maintenance Engineer at Albras in Barcarena, Brazil

Since 2008 several sectors of the global economy still suffering the consequences of the economical crisis. Aluminum producers in Brazil and elsewhere in the world, which has the electricity as the most expensive raw material with the prices trending up, while the aluminium prices (LME) remains at lower level, need to find strong solutions to keep competitively with lower capex. Considering that the baking furnace is one of the most expensive assets of a smelter, the structural diagnostic of furnaces refractory is a key point to find solutions to increase the furnace life without impact on the anodes quality and saving money regarding a later furnace rebuilding. This diagnostic study was carried out by modifying the flue walls in operation of an anode baking furnace at Albras - Aluminum Brasileiro S/A, without replace them, so that extending the campaign of the furnaces without rebuilt nor structurally modifying the baking furnace.

25. Anode baking process optimization: Teamwork guiding to better furnace operation

SPEAKER: Cassio Linhares, Process Engineer for the Anode Baking Furnaces at Alumar in São Luis, Brazil

This paper shows Anode Baking Furnaces improvements in Alumar in 2012. Maintenance, Refractories, Operation and Technology teams working together to construct an optimum scenario of high quality baked anodes production, process stability, cost reduction and operators specialization, achieving good results during 2012 second quarter. Furnaces Team focused on process optimization and operational aspects improvement, generating reduced fuel consumption, better fuel efficiency, lower environmental emissions and stack opacity.

26. History and development of intensive mixing technology for carbon paste preparation

SPEAKER: Berthold Hohl, Manager carbon technology at Maschinenfabrik Gustav Eirich from Germany

Carbon pastes are used in many different fields of the heavy industry, for instance, as anode or cathode blocks for primary aluminum smelting, as graphite electrodes for electric arc furnaces, as carbon bricks for refractory linings, as Soederberg electrodes for reduction furnaces, etc. Over many decades, slowly running batch mixers have been the only useful aggregates for the preparation of these pastes. For anode pastes a continuous preparation process became established later which was based on one or two downstream arranged continuous kneaders. In the seventies of the last century, the intensive mixer started on a triumphal march through this industry. Starting with individual machines for continuous remixing and cooling of anode paste as well as batchwise preparation of various carbon bodies, the intensive mixer constantly opened up new fields of application in the carbon sector. Due to its special benefits, such as high efficiency and an attractive cost/performance ratio, the intensive mixer can be found everywhere in the carbon industry today. The paper describes the most important characteristics and applications, from the beginnings until today.

27. Cooling of anode paste for aluminium production

SPEAKER: Ilio Pellegrino Filho, sales and application engineer at Semco Equipamentos Industriais

The electrolytic melting process for the production of aluminium requires the use of carbon anodes. The manufacture of green anodes consists of mixing of calcined coke and liquid pitch (anode paste) at high temperature, cooling of paste and forming of blocks. As the anode paste is continuously produced an accurate, reliable and controlled cooling process is required to feed the compactors or hydraulic presses with the paste at the right and constant temperature. A continuous kneader is used to produce the green anode paste out of dry material and the liquid pitch at about 160 – 200°C. The continuous cooler reduces the paste temperature down 120 – 150°C at an accuracy of +/- 2°C. The cooling is achieved by addition of water to the hot paste that is fine dispersed by nozzles and sprayed onto the product. The instant evaporation of the water cools the anode paste. The intensive mixing action ensures contact of all product particles with the water. The added water is completely evaporated from the paste and a dry, homogeneous product leaves the cooler. The amount of water is automatically controlled by the product temperature and the product throughput.

28. Advanced fume treatment technologies for paste plants and baking furnaces

SPEAKER: Johannes Schedler, co-founder and managing director of CTP Air Pollution Control from Austria

In the aluminium industry hazardous and heavy loaded waste gases occur which is a major concern for environmental authorities. The hot exhaust gases can contain volatile hydrocarbons (PAH), carbon monoxide and hydrogen fluoride (HF). These emissions occur in the production of raw materials while treating the raw material in the digester, during liquor burning and at the oxalate kiln. They also occur

in primary processes such as the production of anodes for the electrolysis as well as in secondary processes such as aluminium recycling. Changing operating conditions and temperatures, particulate matter, sticky aerosols and corrosive components pose a tough challenge on the function and the safety of any fume and emissions treatment system. This paper presents the latest solutions and considerations for the configuration of waste gas treatment systems for the above-mentioned applications. Basis for this outline is the experience gathered in almost 10 years of operation in various applications and installations.

29. Performance of graphitized cathode blocks from several suppliers.

SPEAKER: João Alberto Ramos Martins, Technology Manager – Potlines at Companhia Brasileira de Aluminio - CBA - Votorantim Metais

It is well known that lining life depends on raw materials, construction, baking control and early operations of started pots. The last two are very important and a close control should be developed in order to have both well controlled preheating and a smooth operation in the first months after start up. Also cathode blocks play an important role and a special attention should be given when choosing them. After changing lining design CBA potlines have reached an average lining life of 3000 days. In addition a decrease in cathode voltage drop was observed. Traditional cathode blocks made of anthracite were replaced by graphitized blocks. Currently we are using graphitized blocks from several suppliers in order to identify the best one that give us a low lining cost and keep or improve lining life achieved after the introduction of the new lining design. This paper shows a comparison of the results of lining life and cathode voltage drop of graphitized blocks from different suppliers. Also the return of the investment is considered to decide which block supplier should be selected.

30. Influence of the sulphur content on wear of the carbon anodes in Hall – Heroult process

SPEAKER: Stanislaw Pietrzyk, Professor of Metallurgy, AGH-University of Science and Technology

Aluminium is produced by the electrolysis of alumina dissolved in cryolite-based melts (Hall-Heroult process). The electrolyte contains some impurities, i.e. iron, silicon, phosphorus, sulphur, etc. The impurities are introduced into the electrolyte with the alumina or fluoride salts or they originate from the carbon anodes. In the Hall-Heroult process sulphur (1-5 %S) originates from two sources as sulphur in the anode carbon and some sulphur contained in the alumina and in the aluminium fluoride. Petroleum coke used for the production of carbon anodes contains 0.7—3.5 wt% sulphur (cokes with higher sulphur contents are usually blended with low sulphur cokes). Cryolite and aluminium fluoride also contain sulphur, mainly as sulphates (up to 1 wt%). Paper concerns research on the effect of high sulphur coke on carbon consumption and carbon dusting during aluminium electrolysis. Electrolytic carbon consumption tests have been performed with graphite anodes with sulphur content close to zero and prebaked anodes with sulphur contents varying from 1.97 to 3.82 wt% S. The tests were carried out in an apparatus where the anode gases were analysed continuously for CO and CO2 during experiments of 6 hours duration. Argon with known flow rate was used as inert carrier gas. This made it possible to make a total mass balance of carbon with respect to the amounts of CO and CO2 evolved in the experiment. The amount of gaseous carbon was compared to the weight loss of the anode sample determined after the experiment, making corrections for the ash content in the form of bath that had penetrated into the anode during electrolysis. The results of this study are indicative of an important link between the sulphur content in the anode material and the carbon consumption. It was found that increasing sulphur content contributes significantly to a rise in the carbon consumption. When going from 0 to 3.82 wt% S, the carbon consumption rose from 108 to 128% (5.2 % per 1 wt% S).

31. Improvements in pet coke analysis at VM-CBA and Petrocoque S.A.

SPEAKER: Jean Carlos Pardo, Process Coordinator at Companhia Brasileira de Aluminio of Votorantim Metais

Anodes for Aluminium production are composed by Coal Tar Pitch (CTP) and Calcined Petroleum Coke (CPC). The anodes composition depends on the reduction technology, this can varies in a range of 67 – 79% of coke and 33 – 21% of coal tar pitch. At VM-CBA the anode technology is well known one called by SØDEBERG Anodes with wet anode top which demands about 32% of CTP and 68% of CPC. The quality of anodes is strongly dependent on the quality of raw materials and production process parameters. The quality control of the raw materials (CPC and CTP) is done by sampling and analyses of chemical and physical properties. The process of sampling and analyses can insert some doubts about R&R, which implies in wrong decisions. Since 2010 VM-CBA and Petrocoque S.A has been develop an study to reduce the Standard Deviation (STD) of analyses for Vibrated Bulk Density that is a CPC properties and also to get an accurately results of the analyses. The results of this work was a reduction of the STD on the Petrocoque analyses from 0,0228 to 0,0045 g/cm^3 and at VM-CBA the STD reduces from 0,0242 to 0,0131 g/cm^3.

32. Comparison of different methods to analyze carbon materials

SPEAKER: Geraldo Fernandes, Chemist at Alumar in São Luis, Brazil

Carbon materials are extensively used in aluminum smelters. The quantification of metals and semi-metals impurities on these materials is very important to control metal quality .There are some different methods to perform this analysis like AA, ICP and XRF. On this work we compare the results from three different methods in terms of lead time, accuracy, precision and safety.