AP Technology™

NEWSLETTER 2020

Sommaire

Jean-François FAURE

General Manager Aluminium Technology

2019 was another challenging year for the aluminium primary industry. The AP Technology™ team continued delivering advanced solutions to optimize existing operations and drive performance : low energy pot modernizations are being implemented with constant improvements and important innovations in both functionalities and product characteristics.

In September 2019, AP Technology launched a worldwide Customer Survey. Thanks to your answers, we have now a precise image of how you perceive our activities, our products and solutions and our capacity to fulfil your needs to your satisfaction. The results confirm our strong brand position and is a very encouraging sign for our teams. This survey has also revealed some points that require improvements to better serve our clients. Our teams are already working on them.

On 20th September 2019, LRF celebrated its 60 years. An official ceremony was held in the presence of French administration representatives, local stakeholders, AP Technology™ partners as well as Rio Tinto senior leaders, employees and guests. For all these years LRF has been at the forefront of smelter technology development and is home for the development of some of the most advanced technology solutions. Important upgrading of the LRF reduction hall was undertaken in 2019 to maintain its position as a core asset to further develop new technologies allowing fast and safe pot reengineering with enhanced performances for amperage creep or energy reduction on any existing platform including AP18, AP30 and AP60. We have also hired a number of new employees to become our experts for tomorrow.

The new generation anode baking furnace without headwalls being demonstrated in our Rio Tinto plant in Bell Bay, Tasmania, Australia and which confirmed the expected significant capacity and CAPEX advantages, has now more than two years of operation and is showing very positive results on the OPEX.

I am very proud to announce that Rio Tinto MAX – the autonomous anode transport vehicle – has now become an industrial reality. On 13 November 2019, MAX had a flawless start with its first tour in Alvance Aluminium Dunkerque Smelter in France opening a period of operational tests in the smelter. It is scheduled to be fully operative in the first quarter of 2020.

2019 was another challenging year for the aluminium primary industry and the AP Technology™ team continued to support global customers by delivering advanced solutions to optimize their existing operations and drive performance in line with their technology and site potential for amperage creep or energy reduction: Low energy pot modernizations tailored to sites ‘contexts are being implemented ; ALPSYS V15 and MESAL 4.0 have been installed at Clients’ sites with constant improvements and important innovations in both functionalities and product characteristics.

We are starting 2020 with a change of our company name which is now Rio Tinto Aluminium Pechiney. The company owns the AP Technology solutions and patents and will continue to provide you with our services and products.

I want to thank all our customers for their longstanding support. Please enjoy reading the interesting updates and news in the following pages. We also would like you to stay tuned with us during the year at our renewed website ap-technology.com where regular posts keep you informed of AP Technology™ activities.

AP Technology™ Customer Enquiry

During the 3rd quarter 2019, we launched a satisfaction survey of AP Technology™ Clients. More than 200 client representatives were contacted across the world on all 5 continents. This is the first survey done since many years, period during which the aluminium industry saw many changes and withstood events of strong impacts.

With the support of Praxis, a specialized research agency in conducting customer satisfaction surveys, we gathered information that gives us robust results that are representative of our Clients and activities.

The Survey Targeted three Objectives :

Evaluate our Clients' level of satisfaction for five activities performed by AP over six themes and 31 criteria

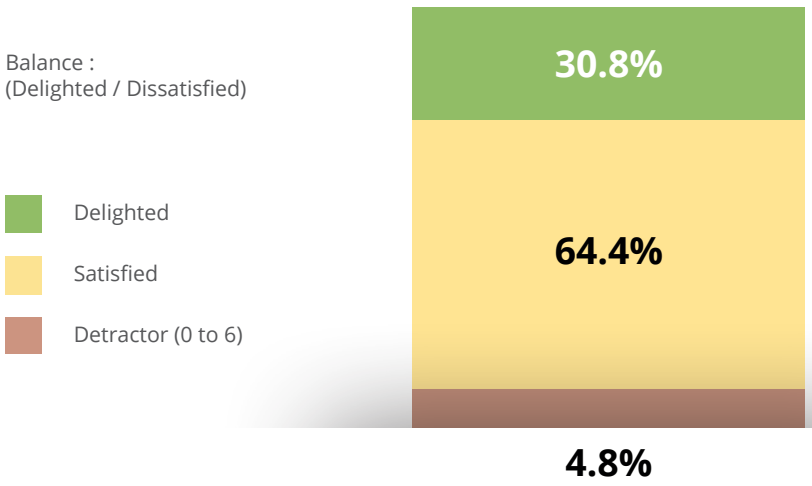
Better understand our Clients' expectations

Identify the priority areas for improvement

Global Satisfaction

Question : « The note you have just given corresponds to what level of verbal scale for you ? »

Balance :
(Delighted / Dissatisfied)



A rate of « very satisfied » (balance of delighted to dissatisfied) at 26% much higher than the average Services Industry benchmark of 17%

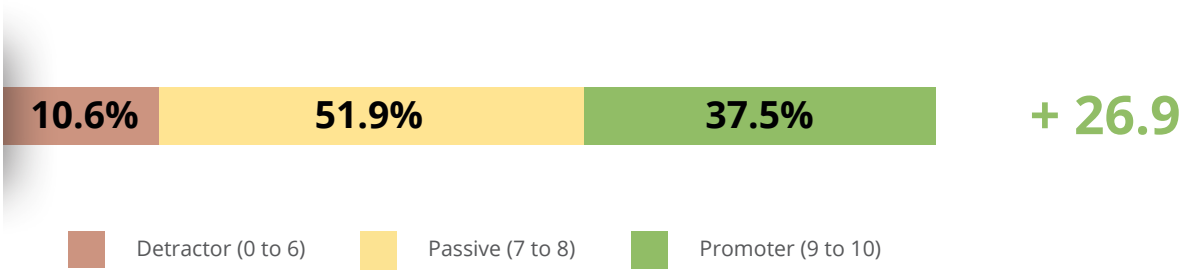
A rate of dissatisfied of less than 5% significantly lower tha the Services Industry benchmark of 13% rate

« 30 % of our Clients are very satisfied of AP Technology »

Level of Recommendation

A NPS score of (+27 %) significantly higher that the Services benchmark (+ 11 %) coming from a higher rate of promoters (37.5 % vs 30 %) and a lower rate of 19 % Detractors (11 % vs 19 %)

Question : « If a colleague or an acquaintance asked you to recommend a supplier of Aluminium Production Solutions how would you recommend AP Technology on a scale of 0 to 10 ? »



Diving in into the results, we can see that the satisfaction threshold is surpassed on all themes but one and for twenty-eight of the selected criteria.

Our Client also singled out that they truly appreciated the technical training and the robustness and efficiency of the solutions proposed by AP Technology. This very good result encourages our AP Technology teams to continue to propose and deliver innovative and value creating solutions to our Clients.

While we are still analysing and working on the action plans to consolidate our strengths, to improve our products and services and to better deliver in the areas our Clients were calling for improvements we have already identified action programs on three priority criteria :

- Resources availability and reactivity
- Commercial and contractual proposition
- Proactivity in solutions development

and three priority themes :

- Pre-project
- Technical support
- Innovation

« Thank you once again to all of our Clients for the time they accepted to give to this survey and for their confidence into AP Technology™ Solutions. »

« The global satisfaction score stands at 7.7 /10 »

LRF : Celebrating 60 years of Technical Excellence in Aluminium

This year, Rio Tinto's Laboratoire de Recherche des Fabrications (LRF) (Research & Development Center) in France celebrated 60 years of creating innovative technologies for the aluminium industry. On September 19 and 20, we celebrated this event with all our employees, Rio Tinto group management, our partners, as well as local and national political figures and Philippe Varin, President of France Industrie. Visitors had the opportunity to see the prototype pots, the state-of-the-art control room and to exchange with LRF professionals on the latest developments and those of the future.

Since 1959, LRF has been a dedicated aluminium research centre – designing, developing and testing new aluminium smelting pot technologies. It has been the driving force behind Rio Tinto AP Technology™ platform: smelting technology that gives us the lowest energy and carbon footprint in the aluminium industry. Thanks to the pioneering LRF employees over the years, successive generations of AP Technology™ smelting pots – AP18, AP30, APXe, AP60 – have been developed here, each offering successive improvements in productivity and reductions in energy consumption and emissions.

AP Technology™ solutions are in operation in our own Rio Tinto smelters and are licenced to external customers. Today, the technology developed at the LRF over the past decades is integrated into more than 10,000 reduction pots around the world, accounting for 17% of global primary aluminium installed capacity.

With its prototype industrial-scale pots, LRF has been at the aluminium industry's leading edge for decades and today innovative projects being currently developed will shape tomorrow's world of aluminium. Today LRF is one part of Aluminium Technology Solutions (ATS) group of Rio Tinto Aluminium which also includes the Aluval technology team in Voreppe, France, and the Arvida Research and Development Centre (ARDC) in Quebec, Canada.
Strong relationships with industry partners, universities, equipment suppliers built over the years have been essential in the LRF long term success. Within Rio Tinto it partners with aluminium operations and Growth & Innovation group to integrate productivity and energy improvements. Externally the network of industrial partners and academics that has been weaved is called upon to bolster our knowhow.

LRF team's skills are recognised around the world through the knowledge and expertise they bring to our work with customers, and the technical assistance they provide.

The LRF team is also working closely with the Rio Tinto-Alcoa ELYSIS joint venture, which is advancing breakthrough technology using inert anodes that eliminates all direct greenhouse gas emissions from the aluminium smelting process – instead emitting pure oxygen.

"Sixty years is an opportunity to celebrate past achievements, but it's also a chance to look ahead to the future," adds Jean-François Faure, general manager, ATS. "LRF is a key player in our industry's next technological revolution, both through developing 4.0 solutions thanks to new smart tools and through its significant contribution to the Rio Tinto-Alcoa ELYSIS project." LRF hasn't finished adding exciting chapters to the history of the aluminium industry and we wish a very happy birthday to LRF and to all those who have contributed to its evolution during these sixty years.

Five Things to know about LRF

- Today, LRF has 70 employees, who work at the R&D facility in Saint-Jean-de-Maurienne in the French Alps, not far from the border with Italy. Over the last 10 years, LRF has generated €20 million in local economic benefits.
- LRF has a mini aluminium potline, with three industrial-scale pots used for testing new technology packages and new pots. The potline uses AP Technology™ solutions developed on-site, including the world's most productive aluminium technology (AP60) and the most energy-efficient technology (APXe).
- The site also has an engineering and modelling office that designs technological solutions for Rio Tinto and third-party smelters.
- Increasing the amperage of reduction pots – the strength of electric current that flows through them – is the key factor in improving their productivity. Since 1990, LRF has increased the intensity of AP30 pots (which was initially at 300,000 amperes) to over 400,000 amperes. These new versions operate at Rio Tinto Alma and Kitimat smelters in Canada and in 12 other smelters around the world. LRF also carries out R&D on process control, on improving understanding of how reduction pots work and boosting their performance by using new sensors and algorithms.
- For more than 30 years, LRF has run the Institut Paul Heroult a training facility named after the 19th century French inventor of the aluminium reduction process. IPH offers training courses for customers of AP Technology™ which focus on understanding

MAX, the Self Driving Vehicle Designed for Smelters

Alvance Aluminium Dunkirk has become the first company to introduce MAX, the anode pallet transport hybrid and autonomous vehicle, in an industrial environment.

The vehicle designed by AP Technology teams and developed by ECA Group has already successfully completed a set of missions in various situations within the facilities of Alvance Aluminium in Dunkirk. Its full and final deployment is scheduled for the first quarter 2020.

Thanks to its guiding technology based on Simultaneous Localization and Mapping, MAX can be integrated to existing operations without any additional equipment or road modification.

From the first test of circulation between the hooking station and the storage of pallets, the vehicle even demonstrated its ability to succeed in manoeuvers and docking perfectly. MAX demonstrated as well its ability to circulate within the plant, whether indoor or outdoor, safely operating and transporting heavy loads up to 12T.

In order to simplify maintenance, all of MAX's actuators are electric. This includes steering, propulsion and lifting of the pallets. MAX has also demonstrated the performance of its auto adaptive docking functions, which allow you to pick up a pallet perfectly, even if it has been placed by a traditional vehicle.

Another strength of the solution is the intelligent Fleet Management System, named LISA-FM, a graphical user friendly HMI which manage the road network, the pallets locations, the smart dispatching of transport mission, and of course the real time monitoring of the fleet.

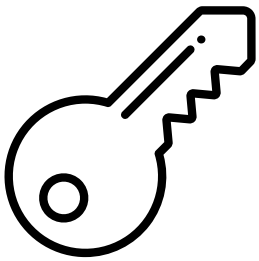
MAX is a safe and environmental-friendly transportation solution aiming at optimizing aluminium production operations. Its name refers to its key robotic features: M for Modular, A for Autonomous and X (cross) for its capability to operate between the different parts of the plant.

Smart Measurement : New Mobile Tool for Alpsys

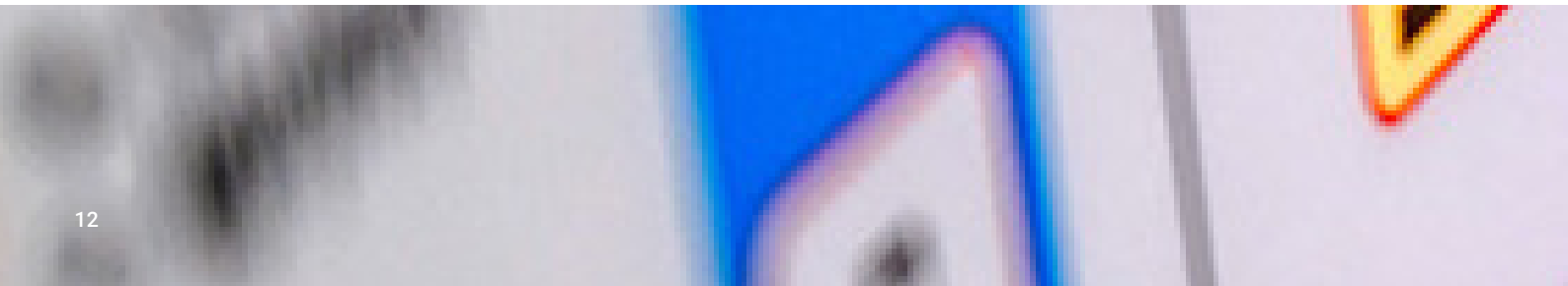
Smart Measurement aims to allow an operator to take a measurement with a probe connected via Bluetooth to a smartphone. A dedicated application on the smartphone guides the operator and checks how the measurement is taken. Then, the application transfers the measurement to the ALPSYS system via a WiFi link. Based on the pot information, ALPSYS will possibly validate the measurement or request an additional measurement or even to supplement the data collected.

This process makes it possible to highlight the measurement compared to the real situation of the pot and thus give the possibility to understand the context of the pot associated with the measurement. If WiFi is available in the potroom, measurement can be sent in real time to the potmicro (APM3 or APM4) or to the level 2 (APM1 or APM2). If not, measurement can be downloaded within the level 2 from the control room.

Key Elements



- Measurement device Modern & ergonomics for operators
- Cost effective replacement of former dedicated portable device solution (same features: scheduled/exceptional measurements & data inputs)
- improved data quality = Smart measure connected with L1 (APM3&4) or L2 (APM1&2)
- Detection & inputs of incidents (anodes, DPAA...) sent to ALPSYS
- User defined custom measurements/inputs (linked to L2 generic data entries feature)



Anode Paste Plant Digital Twin

During the last years, RIO TINTO has been involved in an UE research and development program in the field of industry 4.0 called Monsoon.
This R&D programs aims at developing digital twin model with predictive functions that could be used in a wide range of industries.

For the aluminium smelting industry, a digital twin model predicting the green anode quality was developed and implemented in an operating paste plant. Presentations at different steps of this project have been made at TMS and Forum Aluminium in 2019.

The objective of the digital twin model is to provide a support to paste plant technical staff to improve green anode density. In other words, the objective is to always achieve the best possible green anode density for a given set of raw materials.

The digital twin model operates in 3 steps:

1 – Classification

Real time detection of the 30 minutes' periods of lower quality with two classes : low quality that appears in red and good quality in red

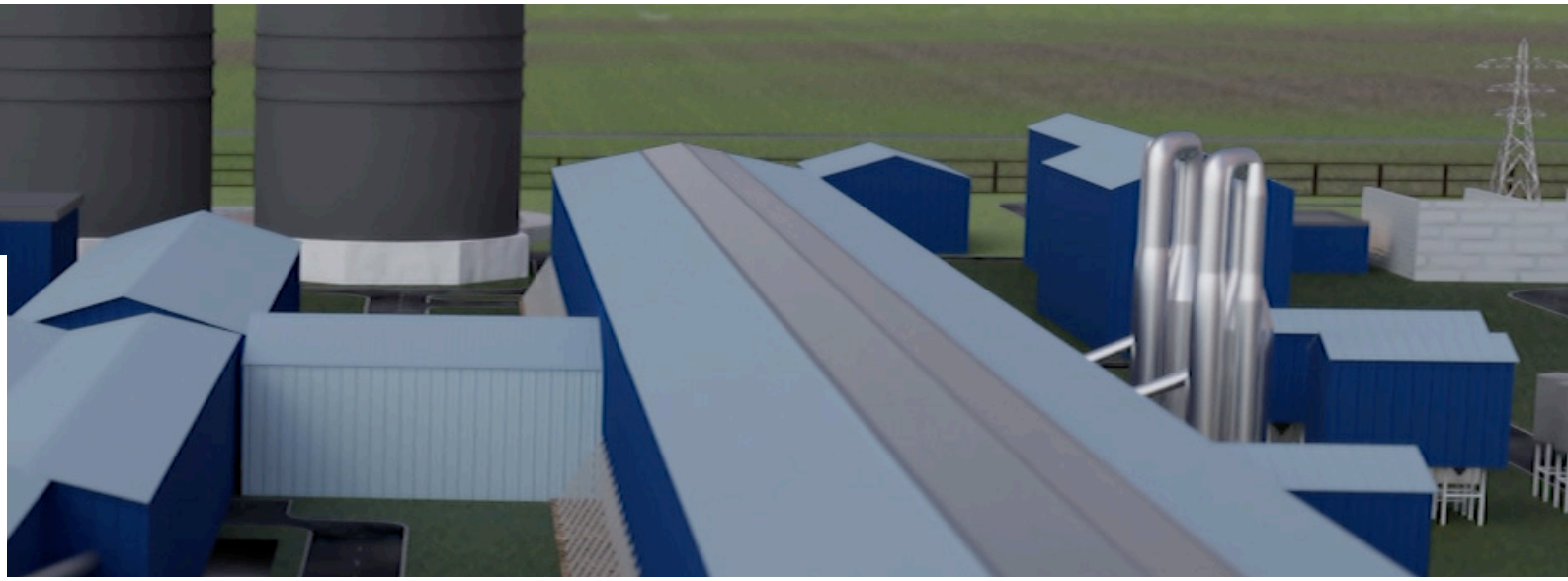
2 – Identification

Identification of the main 5 variables that caused the lower quality and real time information of the process engineer to help him to understand what is happening in the paste plant.

3 – Optimization

In case of low quality, recommendation on 3 actuators to improve the situation

Actuator 1 : Pitch temperature 159.6 => 176.9°C
Actuator 2 : Heater temperature 195.0 => 201.8°C
Actuator 3 : Mixer / cooler temperature 159.0 => 153.0°C



The recommendation is based on a list of 3 actuators with set point; the possible gain in density is also given by the function.

To feed the algorithm, data is collected from an historian. The digital twin model is training itself every 8 hours using the data from the last 6 months. This learning process allows the system to self-adapt to changes in the physical world and to quickly take into account process step changes.

The project is well on tracks:

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The digital twin model operates in 3 steps:

- Successful implementation of a digital twin model in an aluminium smelter
- The tool is visual, simple and auto adaptive
- The paste plan digital twin opens optimization possibilities in paste plant

This project unlocks many possibilities for the use of digital twin models and their associated predictive functions in every area of aluminium smelter.

Remote on-line Process Support

Over the last decades, AP Technology™ has developed, flawless processes and methodologies to provide our clients with the documentation, the know-how and the offsite and onsite support needed to implement and operate their AP Technology™ solution. Today development of communication network and business analysis tools allow us to implement a new approach based on a combination of remote on-line process support and onsite short term missions that we call Technical Assistance 4.0 or AT 4.0. We started to provide such service to a few smelters late 2016 and have continuously increase the number of clients supported by AT 4.0. In 2018, we created the AT 4.0 team, bringing together AP Technology™ reduction process experts to deliver AT 4.0 services to our customers.

One team with multiple objectives

Bringing all our experts into one single team provides the opportunities to standardize and improve our tools and methodology as well as to be able to ensure the continuity of the support to our clients over time. Sharing and teamwork are the part of the DNA of our AT 4.0 team. RADAR and ALPSYS dash-boarding tool are our key tools to facilitate data analysis and to create ready-to-use standard reports and dashboard.
Our experts' great knowledge of the reduction process and ALPSYS is unique and we are further developing it for the benefits of our clients.

The Services

Now fully integrated with the implementation of AP Technology™ solutions' the team supports modernization or greenfield projects, roll-out of ALPSYS projects and provides technical assistance to operating smelters.
Services combine on-site short-term missions to ensure a good knowledge of our clients' facility and to help build good relationships with the site teams with remote on-line process support which takes place through period data analysis and conference calls, usually on a fortnightly basis.

Today six smelters are currently benefiting from our AT 4.0 services.

Team AT 4.0


Aluval
Chef de produit AT 4.0
LRF
Jean-Luc BASQUIN
Laurent FIOT
Eric MELAT
Serge RISSER
Bertrand ALLANO
Sébastien BECASSE
Jean-Pierre FIGUE
Johan MIZZI
Patrice PALAU
Géraldine TOYE Assistante
Bernard MOLINIER
Steeve RENAUDIER

Anode Baking - From OoM to Commissioning

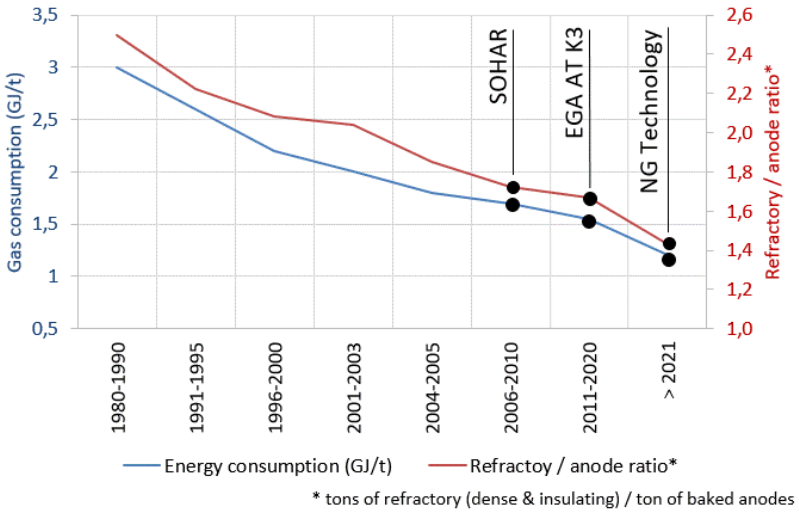
Anode quality is crucial to the safe and optimal operation of any potline. More specifically, consistently achieving the desired baking quality while securing the anodes inventory at optimized costs is critical for the satisfactory performance of any anode plant and ultimately aluminium smelter.

Pechiney developed and started in 1958 its first open-type anode baking facility in L'Argentière in the French Alps. This new technology was firstly deployed internally in the 60's and 70's in plants such as Aluminium of Greece (1967). The technology started to be sold in the 70's with the furnaces of Alro (Romania), Nalco (India) or Alcoa San Ciprian (Spain).

Since then, the design and operation have been improved over the decades thanks to innovation and the unique position of Rio Tinto to be at the same time a designer and an operator of baking furnaces. In 2020, 60 furnaces using AP design are in operation and produce approximately 7.2 million tons of baked anodes per year.

Today, AP Technology™ knowledge and experience in anode baking furnaces and the unique source of feedback from over 60 years of design, erection, operation and retrofit is made available through our engineering and technical services to support new projects and modernisation

Initially an anode baking furnace is designed for an anode format and a production output. When time comes to modify the anode format, as homothetie does not work for thermal laws, the furnace size and dimensions are adapted to the desired dimension and output through several modelling phases using the latest technology improvements. Various options are analysed and compared in terms of technical features, operability and costs leading to a first layout taking into account the site main constraints and finding the best compromise with the following factors: number of pit per section and number of sections per fire, number of fires, fire cycle. Thanks to the development of dedicated modelling tools, AP Technology successfully increased pit and section size over the years with a result of improved energy efficiency.



Anode baking furnace design evolution over 30 years leading to a 30% reduction in GJ/t and an anode refractory ratio of 0.7

With the global sizing of the furnace agreed among the various players of a project, the refractory team enters into action with the proper detailed design of the furnace. Working hands in hands with process and operation experts, the refractory experts define the detailed refractory design of the furnace. Anode baking furnace is indeed a very unique and complex assembly of several thousands of refractory bricks. Experience and expertise are a "must" at this stage to define the detailed design of the fluewalls, headwalls, insulation and other parts of the furnace in order to ensure the lifetime expectancy and the baking homogeneity. With nearly 20,000 fluewalls currently in operation around the globe, AP Technology has unique experience and knowledge on this phase.

Once all the detailed engineering is finalized, bricks can be produced by refractory suppliers. The manufacturing quality, both the geometrical dimensions and the chemical and physical properties, is of critical importance to ensure a satisfactory erection and sustainable operation of the furnace. AP Technology supports its clients with the quality control at supplier premises for the dense and isolating refractory. This is currently happening for the on-going revamping of Rio Tinto Alma furnaces.

The furnace construction is another critical step. It involves an important workforce to correctly assemble more than 1 million bricks within the allocated timeframe. AP Technology supports its clients with expert resources delegated on site to follow on a day-to-day basis the erection of the furnace. This ensures the right quality is applied until the furnace is ready to be started. At this time the AP Technology operation and process team join the site to support the local team with the start-up of the firing system and the daily operations. The aim here is to reach a sustainable organization in terms of operational practices and knowledge to achieve the expected anode baking performances.

Once the furnace operation reaches its steady state, AP Technology continues to support its client through regular technical assistance activities such as audits, trainings and optimization mandates until the next retrofit of the facility.

- Order of magnitude & Pre-feasibility studies
- Technology Transfer
- Basic engineering of the anode baking furnace building and its ancillary shops
- Detailed engineering of the baking furnace refractory, insulation and concrete casing
- Training at our Institut Paul Héroult
- Support during construction, commissioning and operation
- Refractory supply quality control services

Electrolysis News

Alro AP12LE

Alro, one of the largest aluminium smelters in Continental Europe, and AP reached an agreement in April 2018 to implement at Slatina a new low energy reduction pot design (AP12LE) that will allow Alro to reduce the amount of electricity needed to produce aluminium.

Mozal AP3XLE

The AP3XLE project targeting 378kA and 13.0MWh/t is on track.

Since Sept. 2018, all stopped pots have been relined using the AP3XLE technology.

In 2019, the strong process collaboration between Mozal reduction team and AP Technology experts continued thanks to missions on site and regular phone conferences with our AT 4.0 team. The combination of periodic onsite short missions and regular remote process reviews demonstrates once again the efficiency of our AT 4.0 support model.

At the end of 2019, 25% of the pots are converted and the first step of amperage creep is planned for early 2020.

Interactive Online Advanced Training

The Institut Paul Heroult (IPH), AP Technology™ training centre, continues to develop and to improve AP Technology™ training offer.

To answer the needs expressed by several smelters to get access to more technical training material on very specific subjects, a new advanced training format was developed and successfully implemented in 2019.

On specific technical subjects, IPH organized a half-day video conference session with participants located in one or several smelters. The trainees are already experienced in the domain. The trainer, a senior expert, presents

the chosen subject and interact with the participants to capture and share their experiences. The use of modern interactive tools like touch screen or klaxoon®makes the format attractive.

The conference is recorded and IPH provides to the participants access to both the presentation used and the video for later use wit hin each plant.

The topics already covered by such Advanced Training sessions are the following:

Substation : open circuit and Surmec settings
Alpsys: Robustness
Alpsys: HF/BF
And more will come in 2020....

Sohar Aluminium, Benchmark Operations

2 years after the unexpected open circuit incident that led to the complete stoppage of the Potline (stoppage in August 2017 – full production resumed in January 2018), Sohar Aluminium has been exhibiting benchmark operational performance with its AP40 pots. Some of the benchmarks achieved by Sohar Aluminium in 2019 are:

Safety: AIFR at 0.17 (Jan to Dec 2019).

Environment: Anode Effect Rate at 0.17 AE/PD (Jan to Dec 2019).

Amperage at 395 kA and specific energy consumption at 13,181 kWh/t Al, with Fe level below 600 ppm, and Net Carbon at 408 kg/t Al.

Sohar Aluminium is now ready for its next amperage increase step, 400kA and beyond.

Sohar Aluminium was formed in September 2004 to undertake a landmark Greenfield Aluminium Smelter and has an annual capacity of 390,000 tonnes of high-quality Aluminium, a 1,000 MW power plant and port facilities in Oman.

Jointly owned by OQ Group, TAQA and Rio Tinto, Sohar Aluminium has won global acclaim for its superior, environmentally friendly technology.

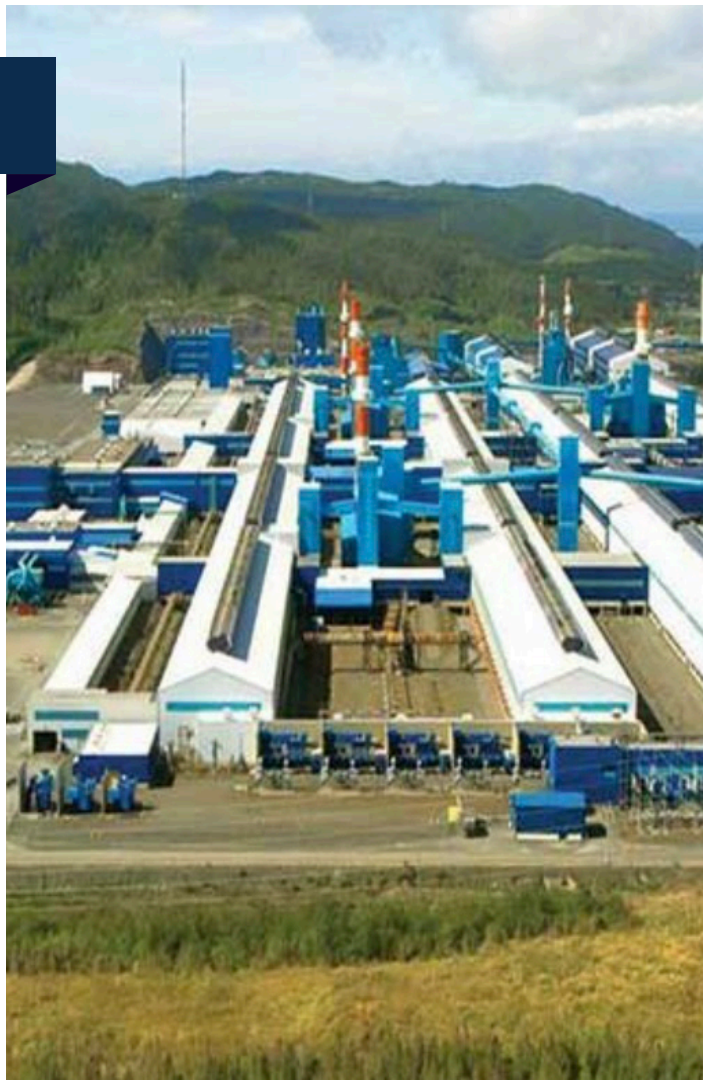
Elysis

ELYSIS launched the construction of its R&D center in Saguenay on August 16, 2019 where technical experts will continue to advance the breakthrough technology that eliminates all direct greenhouse gas emissions (GHG) from the aluminum smelting process.

ELYSIS will continue to work closely with the Rio Tinto Aluminium Pechiney technology design team in France and Alcoa's Technical Center (ATC), near Pittsburgh in the United States, where this patented technology was invented by Alcoa. Since 2009, Alcoa has been producing research-scale metal at ATC with no direct carbon emissions from the smelting process.

Late December Apple proceeded with the acquisition of the first commercial batch of aluminium produced using the breakthrough ELYSIS™ carbon-free smelting technology.

AP40 Alouette



18 months into the project which started mid-June 2018 more than 300 pots have been converted to AP40 pots. As we go to print the installation of the Forced Cooling Network (FCN) on Potline 1 is nearing full completion and the Alouette teams are ready to switch on the FCN leading the way to increase the amperage on potline 1 in a matter of days.

The ALPSYS robustness module was rolled out on both potlines and switched on mid-year. This module allows for enhanced pot resistance and slope calculations leading to reduction in the pot noise level, a narrower alumina content range and less pot additional resistance over target.

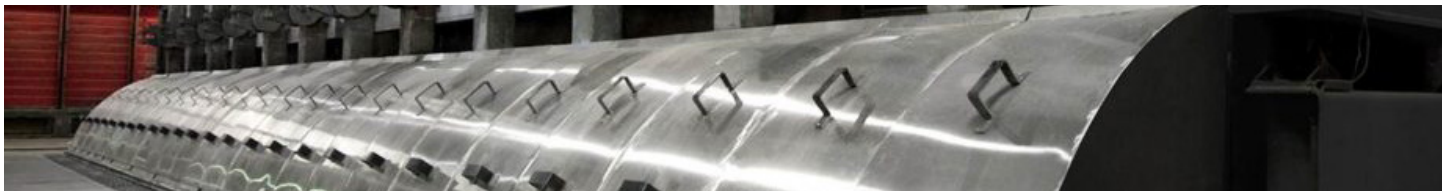
The Alouette and AP Technology teams have been working very closely for the past 18 months on matters ranging from potshells and conductors to operation and process practices in order to be ready for the amperage increase.

During 2019 following intense collaboration by all involved, the Alouette teams achieved to restart up to 26 pots in a month, a level never reached before at the plant.

APXE & AP60 Platforms during 2019

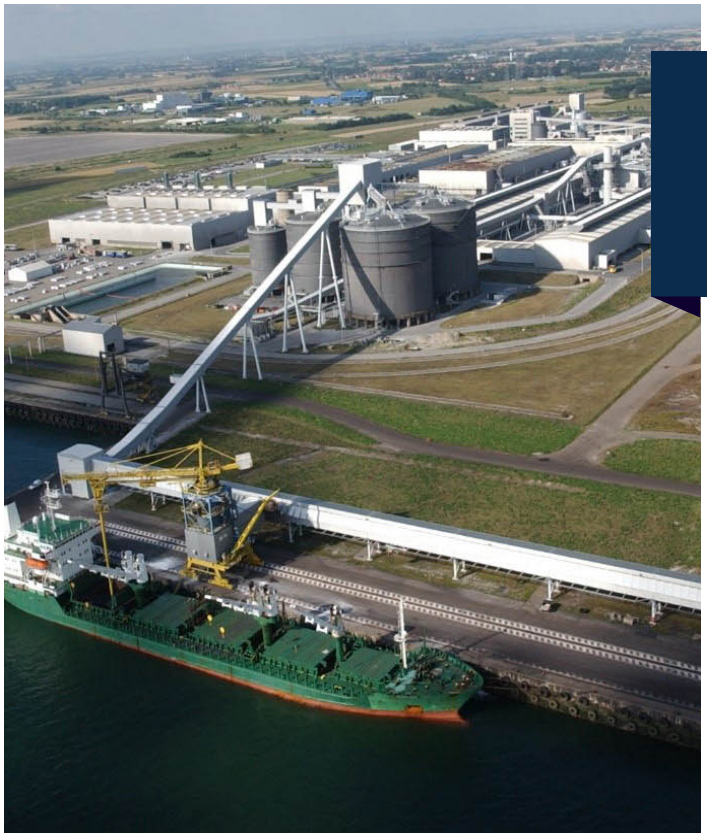
During 2019, RTA/AP continued to work on enhancing the performances of both its platforms AP60 (Jonquière –Canada) and APXe (LRF – France).

At AP60 Jonquière, considerable work has been devoted to further increase the amperage and enhance the performances of the AP60 pots. This required implementing upgraded existing technology bricks such as alumina feeding and process control procedures and developing new ones for the pots that are in the boosted sections. The results are that amperage on these pots has been increased by nearly 10% while maintaining operational results.



At LRF, the APXe pots have been relined as well as upgraded with the latest versions of existing technology bricks in order to be able to support the development of new technology bricks aimed at consolidating the pot operations at very low energy consumption. to go beyond 600 kA and below 12000 KWh/t.

To sum-up, AP technology teams having passed the targets of 570kA and 12000kWh/t are now focusing their effort on the next steps to deliver reduction platforms going beyond 600kA and below 12000kWh/t.



Advanced Aluminium Dunkerque: Support, Modernize & Develop

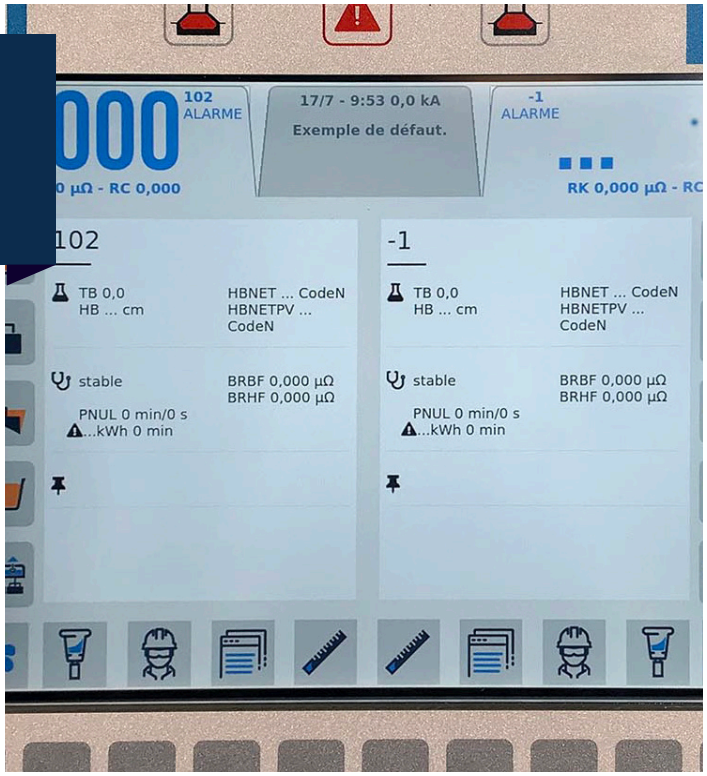
As part of the on-going relationship with Alvance, AP Technology teams performed on-site audits and held quarterly operations reviews in the key sectors of Reduction, Casting, Anode Baking, Environment and Substation. AP Technology is also supporting the plant in its implementation of the creeping project AD415 which will see the plant operate at 415kA and below 13000 kWh/t. Furthermore, several development projects and trials are being pursued jointly by AP Technology and Alvance at the smelter targeting to improve the smelter competitiveness with improved pot process control procedures, enhanced pot equipment, alternative pot designs as well as Anode Baking Furnace energy saving and safety improvements.

Alpsys APM4: The new generation of potmicro is on track

This project aims to deliver the new generation of potmicro that host ALPSYS Level 1 functionalities. The new potmicro named APM4 will replace the existing APM1, APM2 and APM3 models in plug and play mode and includes new technological advances (accessed by tablet, advanced management of new sensors on pots, graphical HMI, ...)

The APM4 project is on track with the APM4 prototypes:

- manufactured and assembled
- installed in the LRF environment
- having successfully passed all the hardware tests in magnetic fields.



APM4 is designed to work in a 200 Gauss environment and following the tests have now been validated up to 500 Gauss (0.05 Tesla).

Forthcoming steps are:

- to perform the detailed validation of hardware & software (process control) by implementing APM4 on live pot in LRF beginning of 2020.
- to install APM4 potmicros on a group of pot in a potline during S1/2020 to complete the industrial validation.

1600 pots are now operating with ALPSYS V15 which includes modern web HMI, embedded new IT features and new Process Control features such as Robustness.

Alpsys V15 Go-Live on 3 additional Smelters in 2019

The new Version V15 of ALPSYS has been implemented in 3 sites in 2019.

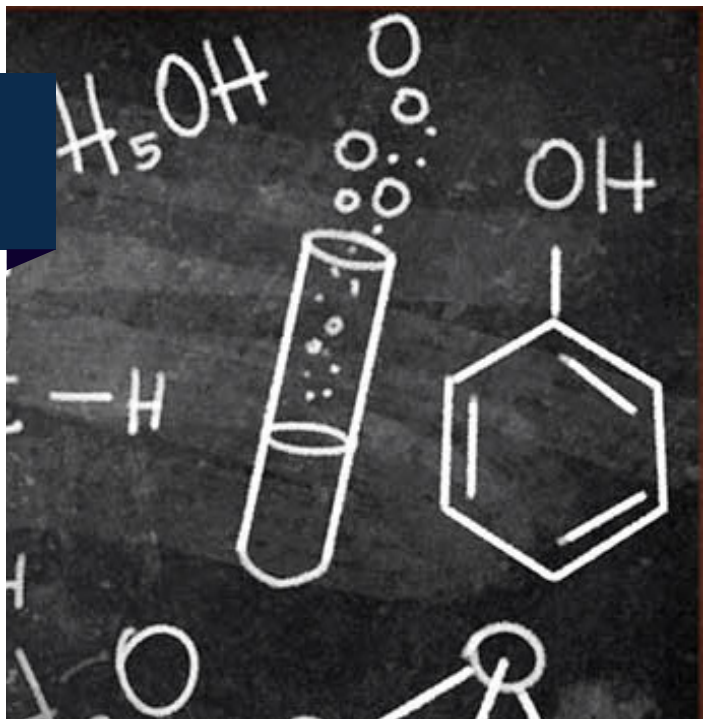
- In February, UGB Rio Tinto smelter (Quebec) has deployed ALPSYS V15 on 3 potlines (384 pots) running P155 pot technology.
- In April, MOZAL (Mozambique) has deployed ALPSYS V15 on 2 AP Technology™ potlines (576 pots)
- In November Sohar Aluminium (Sultanate of OMAN) has deployed ALPSYS V15 on 1 potline of 360 AP40 pots

ALPSYS V15 is on track to be deployed in S1 2020 at Tomago smelter (Australia) in 3 potlines (840 AP2X pots).

New Features in Development for Alpsys

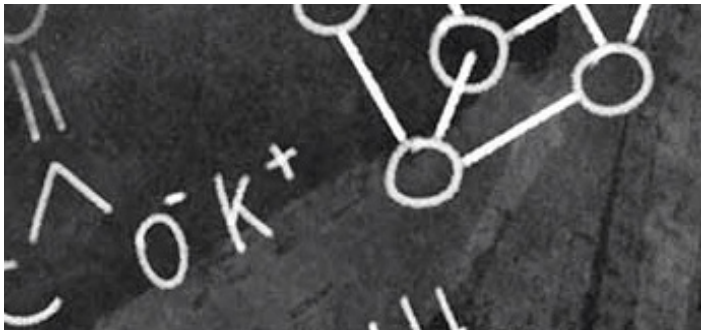
Your production is facing changes and your process engineers need to quickly test new approaches? #HashTag allows them to create on the fly their own process indicators. #HashTag is an additional ALPSYS function that enables the user to create new data (the "Tags") based on existing ALPSYS data and on other Tags.

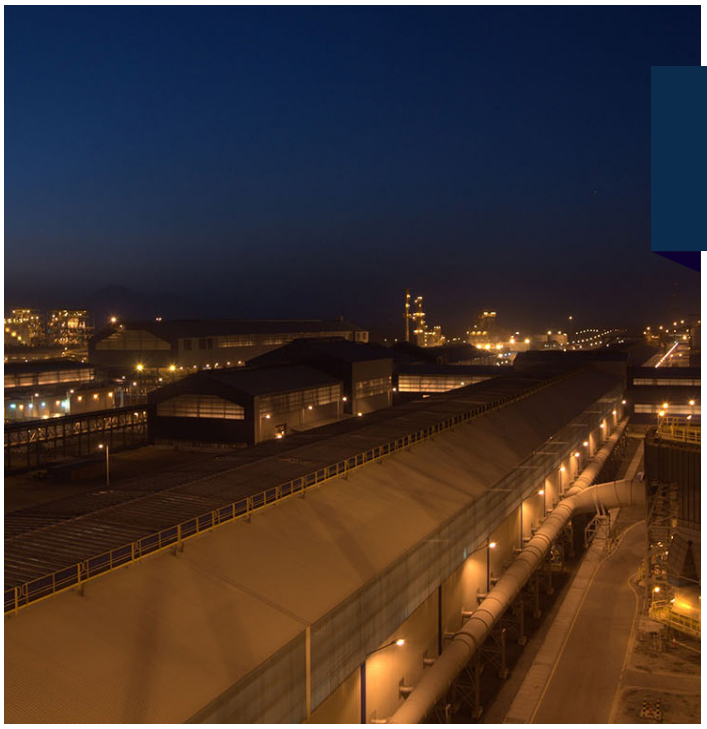
This new module will therefore complement the existing ALPSYS database and is develop with 3 objectives:



- intuitive language and ergonomic interface
- new indicators available immediately for present and past values
- available everywhere when relevant in Alpsys & Radar suite.

The goal is to allow ALPSYS users to create themselves their customized indicator without need for IT development or database configuration.





MESAL 4.0 is now running in Middle East

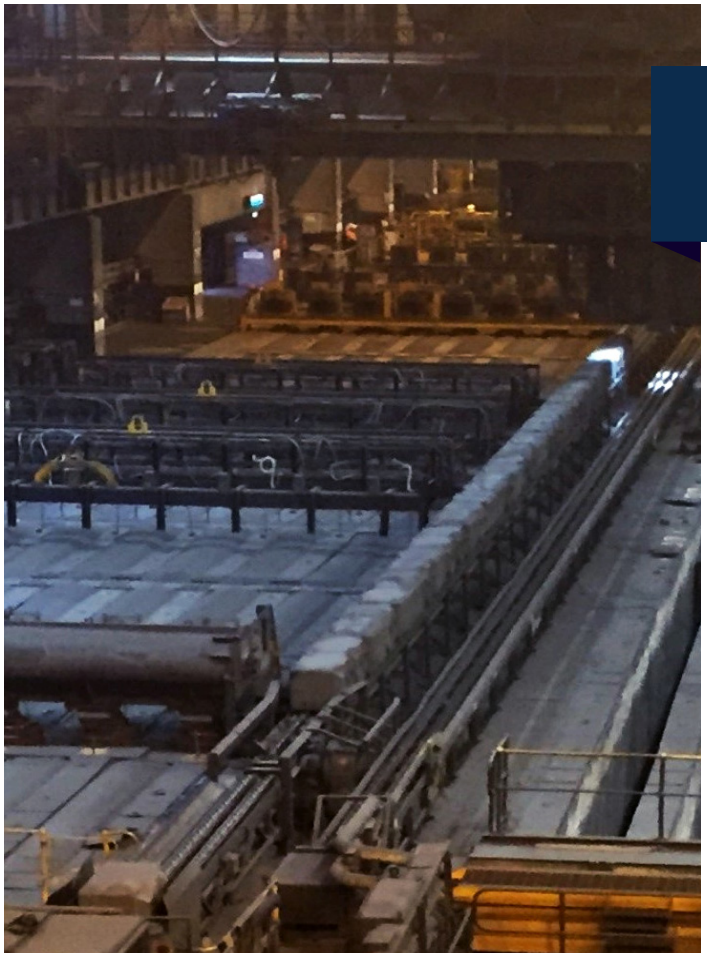
The latest version 4.0 of MESAL™ has been successfully deployed in two smelters in Middle East region.

- Sohar Aluminium (Sultanate of OMAN), initially the first MESAL™ customer has upgraded the former version 2 running in all the sectors of the smelter (Reduction, Carbon, Casthouse and general Services) in the new 4.0 version. With Kitimat (British Columbia – Canada) Sohar is the second smelter to use MESAL 4.0 version in all the sectors of the smelter.
- At the same time, ALBA (Kingdom of BAHRAIN) has started the MESAL™ 4.0 solution for its Carbon and GTC areas within the L6 project.

MESAL™ 4.0 reinforce its position in smelting management within the Middle East region. Other sites using MESAL™ 4.0 are the Rio Tinto smelters in Quebec: Alma, UGB, AP60 Jonquière and Laterrière.

AP Technology™ team is currently developing new enhancements to come around mobile device to allow a MESAL™ usage on shop floor.

Carbon News



Bell Bay Aluminium Smelter

2 years of successful operation of our new NG anode baking furnace design

The industrial prototype is successfully operated by Bell Bay Aluminium since December 2017. To date, the converted zone (33 meters long pits) allowed Bell Bay Aluminium to produce approximately 8000 additional anodes (+ 15% productivity) with a confirmed 35% reduction in gas consumption and with no impact on anode quality. Operation and engineering teams are now working on a possible extension of the zone in order to increase further the Bell Bay anode baking capacity.

As a reminder, the NG Technology concept patented by Rio Tinto is based on removing partially or totally the headwalls to increase the anode loading ratio. The number of headwalls to be removed is selected depending on the anode dimensions in order to accommodate either an extra set of anodes or an anode dimension increase.

Alma Aluminium Smelter

Anode baking furnaces retrofit works scheduled for 2020

Alma anode baking facilities (2 furnaces of 48 sections with 7 pits per section) designed by Alesa were started in 2000. In 2020, the dense refractory (fluewalls and headwalls) as well as the insulation and the crossovers will be completely renovated. Both furnaces will be raised by approximately 0.6m in order to allow the baking of longer anodes. AP Technology™ baffleless fluewall design will be used to decrease the renovation impact on the fume treatment facility and the corresponding investments.

Since the preliminary studies, AP Technology™ Carbon team is part of the integrated project team for the supply of the refractory design. We also support Alma team for refractory quality control at supplier premises and we will be a key player for the construction and the start-up of the renovated facilities.

AP Technology™ Anode Baking User Club 2020

Coming conference in Sohar on March 10th and 11th

In 2020, there are more than 60 anode baking furnaces of AP Technology design operating around the world.

With the belief that sharing and cooperation is one of the keys to solve today's and tomorrow's challenges, we are organizing the next AP Technology™ Anode Baking User Club conference in Oman in March 2020. Realized in partnership with Sohar Aluminium, it will gather Anode Baking Furnace operators from all continents. The conference will be framed around a benchmarking exercise realized at the end of 2019 and numerous presentations of the participants about anode baking furnaces operation and maintenance.

Modeling Tools to Optimize Anode Baking

It is well known that the process and operational parameters of the anode baking furnace have significant impacts on the anode quality and the performance of the furnace. Among those parameters, the gas injection is critical to achieve the targeted baking level at optimized costs while respecting the emissions limits. However industrial trials are often long, costly and influenced by many uncontrolled parameters.

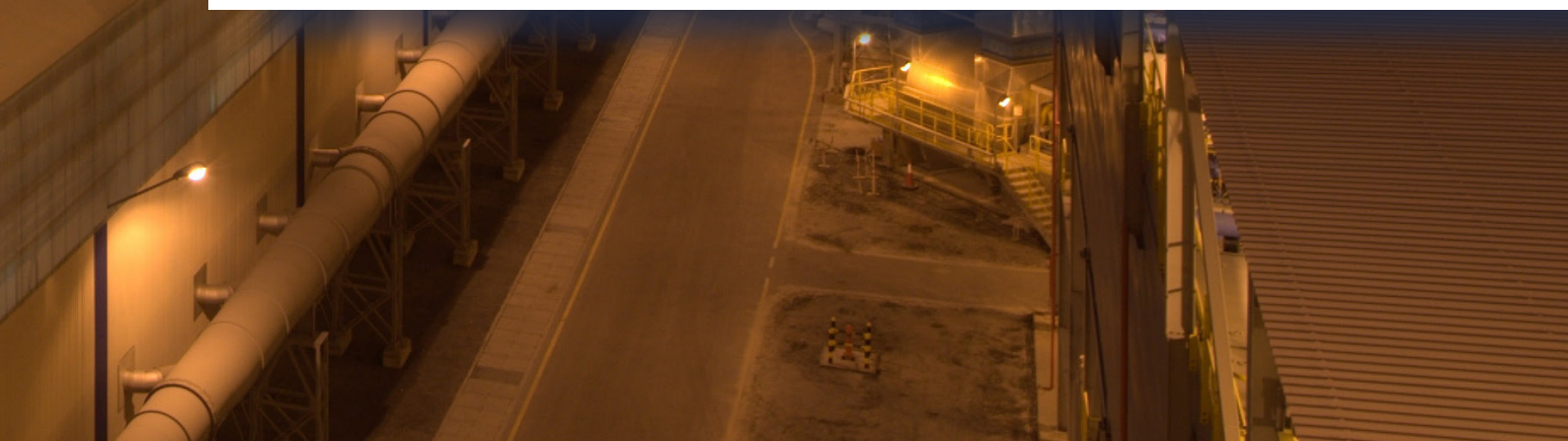
AP Technology™ carbon team has been developing and using for several years an entire set of modelling tools to anticipate the impact of numerous operational, design and process parameters.

Our latest model focuses on the behaviour of the gas pulsed combustion in the heating zone. Through sensitivity study, it is now used to support decision making in the design phase of all projects in order to:

- Define the range of operation of existing and new/future firing ramps,
- Adjust the internal design of fluewalls, for example to check that the baking level will be maintained for raised fluewalls,
- Identify the challenges/opportunities to maintain/improve anode baking performance and anode quality,
- Check the safety of our installations in degraded mode.

Rio Tinto Aluminium Articles TMS 2020

Rio Tinto Aluminium will deliver the following presentations at the TMS2020 Light Metals Conference in San Diego, 24 February to 27 February 2020



Validation of the Gravimetric Method to Properly Follow Alumina Dissolution in Cryolithic Bath

A gravimetric method was developed to study alumina dissolution kinetic by following the evolution of the apparent weight of alumina samples while immerged into a cryolithic bath. It is the change of the gravity and buoyancy on the sample that can help to determine the dissolution rate. The experimental results obtained by this method were compared to four other values; those found in the literature, a CFD model developed by our team, the total mass difference over experience time and finally to a boundary displacement method.

Optimization of a Gas Traitement Center Equipped with Extended Surface Bag Filters:

Results of the test work that was conducted on the Gas Treatment Center installed at the Rio Tinto AP60 Technology Center located in Canada on the GTC which was originally supplied with standard filter bags except for one filtration module equipped with extended surface filter bags. Back in 2017, the original bags were approaching the end of their useful life and the test work was launched to acquire a deep understanding about control of process parameters to optimize the GTC performances if ESB filters would be installed in all filtration modules.

Model Based Approach for Online Monitoring of Aluminium Production Process

Model Based Approach for Online Monitoring of Aluminium Production Process: This article presents a novel approach for estimating on line alumina concentration and the anode-cathode distance (ACD) in a regular aluminium-reduction pot cell using a Linear Kalman Filter. This is done by using an appropriate dynamical model for the pot, which is obtained by combining the first principle modelling and experimental identification of alumina concentration behaviour from irregular sampled data. Moreover, a dynamical model for the pot resistance is identified as a function of the alumina concentration and ACD data. The proposed approach is validated on an industrial platform.

Mass Transport By Waves on the Bath Metal Interface in Electrolysis Cell

This paper reviews the literature on the works already done on the study of surface waves, interface waves and Stokes drift (movement of waves on the surface of a fluid is always accompanied by a displacement of the particles in the wave propagation direction) and presents estimates of the mass transport induced by these waves for the case of the metal bath interface for material, such as rafts of alumina and solidified bath, particles of undissolved alumina, cryolite snow.

Development of a Mathematical Model to Simulate Raft Formation

A Lagrangien model, called CuDEM and destined to simulate the alumina feeding process is presented in this paper. The first part of this model focuses on the interaction between the spherical particles and their environment by resolving the movement's equation using discrete element method. The second part uses the smooth particle hydrodynamics to simulate the flow and freezing of the bath during raft formation.

Major Reconstruction of Central Casing of Open top Baking Furnace

In cooperation with AP, Aluminium Company of Greece will present its major reconstruction of central casing of open top baking furnace of more than 50 years old with a view to increase its lifespan and reduce the total costs comparing to full reconstruction. The different phases undertaken in order to successfully develop and safely realize the replacement of the casing walls in the central passage as well as the anode conveyor supporting structure are detailed along with the technical challenges, the innovative solutions and the project organization for this work which was completed without any safety incident and in a strict schedule of ninety days.

Modeling of Gas Injection on Anode Baking Furnace and Application to Operations

In this paper, a 3D model for the combustion of pulses of gas in the heating sections will be presented, a model which focuses on the flame behavior in order to precisely represent the gas pulses, the quality of the combustion, the heat transfer and the emissions. The effect of the parameter variations on operation will also be presented.

Higher Baking and Production Levels in Anode Baking Furnaces and Associated Challenges

The paper describes projects that were simultaneously executed in two of Rio Tinto's North American smelters and describes the work performed to achieve both a higher baking level and higher production. Optimisation of the baking curves is discussed, along with the issues that arose during the project and the solutions that were put in place.

Additive Selection for Coal Tar Pitch Modification in Aluminium Industry

This paper describes the method undertaken to establish an additive selection method which would yield improved coke wettability by modified pitch and presents the results for three different additives. Non-modified and modified pitches were characterized by carrying out wettability tests and FTIR analyses. Coking values of non-modified and modified pitches were also measured. The results show that it is possible to improve coke-pitch interactions via the utilization of additives.

The LCL&L Process, a Sustainable Solution for the Treatment and Recycling of Spent Potlining

In 2008, Rio Tinto inaugurated a new plant in Jonquière (Québec) for the treatment of 80 kt of SPL annually, based on the low-caustic leaching and liming process (LCL&L) developed at Arvida Research and Development Centre in the early 1990s. LCL&L process characteristics are described, including valorisation routes for its by-products and some recent improvements of the process to reduce treatment costs with better energy efficiency

Effect of Water Flow Distribution on the Performance of Aluminium Small-Form Ingot Continious Casting

This paper presents the effect of water flow distribution in the cooling basins on the ingot solidification and ingots constraint stress. The water flow parameters at three sections in the cooling basin were tested. The complete ingots cooling profiles, mould temperature profiles and the demoulding rate in correlation with the water flow distribution were evaluated. To secure the ingot quality and the casting performance, key process parameters and issues were identified and the best practice was explored.

Other Presentations during 2019

January - At the Incal 2019 Conference held in Bhubaneswar, India

We presented four technical papers covering a wide range of technical solutions:
http://www.meetingsnmore.com/incal%20third%20layout/#
Innovation and development in alumina refining capability (D Holmyard)
Low Caustic Leaching and Liming (LCLL) for the treatment and recycling of spent potlining material (S Poirier). Expertise and methodology for improving aluminium smelter efficiency (B Feve)
Evolution and perspective of ALPSYS pot process control to support productivity improvement (P Marcellin)

May - At the Future Aluminium Forum ICSOBA, Warsaw

A Augé presented the predictive functions developed and implemented using big data analytics applied to optimize green anode production and reduction processes on the operation platform developed in the Alvance Aluminium Dunkerque smelter (France) during the Monson Project. [Monsoon is a European project (European Union's Horizon 2020), it means MOdel based coNtrol framework for Site-wide OptimizatiON of data-intensive processes].

June - At Trondheim

B Allano participated to the 2019 International Course on Process Metallurgy of Aluminium in Trondheim for a session on New Development in Computer Control of Aluminium Cells.

June - At the Air and Waste Management Association Meeting

At the Air and Waste management association meeting, we presented three papers covering:

Industrial process dust management, a short range LiDAR for fugitive emissions quantification (Jonathan Bernier). The LCL&L process: a sustainable solution for the treatment and recycling of spent potlining (Laurent Birry). Valorisation of synthetic anhydrite in blueberry fields (Marie-Christine Simard)

September - At the 37th ICSOBA Conference in Krasnoyarsk

R Chahine presented a paper on the design of magnetic solutions using MHD code to study the stability of aluminium electrolysis pots and the role it can play in using boosters in smelters in order to develop and test new AP technology pot improvements and in calculating the pot MHD stability limit for creeping and designing solutions in case of unstable pots.

Christos Zarganis of AoG (Greece) made a presentation on the major reconstruction of the central casing of its open top baking furnace with a view to increase its lifespan and reduce the total costs comparing to full reconstruction. The article details the technical challenges and innovative solutions as well as the project and operation organization put in place in order to realize the work without any safety incident and in a strict schedule of ninety days. (in collaboration with AP).

David Wong made a presentation on challenges and latest progress in IPCC methodology for estimating the extent of greenhouse gases co-evolved in the aluminium reduction cell, covering both anode effect and low voltage emissions – respectively termed 'high voltage anode effect' (HVAE) and 'low voltage anode effect' (LVAE) emissions (in collaboration with RTA).

September - At the Gulf Aluminium Council Carbon Conference in Dubai

Arnaud Bourgier presented the latest development on modelling of gas injection on Anode Baking Furnace with a focus on the behaviour of the flames during the gas injection and the understanding of the phenomenon involved in the gas combustion and the effect of different burner parameters on the operations.

Light Metals Award

This award recognizes an individual excellence of a paper presented the preceding year in a Light Metals Division sponsored session at the Annual Meeting.

Current Year Awardee(s)

2020 Light Metals Award

Sébastien Guérard

Show Details

Title: Research Scientist

Affiliation: Rio Tinto Aluminum, Arvida Research and Development Center

Quote: For me, TMS was always the main global organization within the light metals industry. I have been reading and learning from its publications since I was a student, and its annual meeting is the best event to attend in order to network and keep up with the technical advances in the field. It is therefore a great honor, and one of the highlights of my career, to receive an award from such an important and prestigious institution. I also consider it a recognition of the technological leadership of the aluminum group at Rio Tinto.

Other: "A Transient Model of the Anodic Current Distribution in an Aluminum Electrolysis Cell," Light Metals 2019

2020 Light Metals Award

Patrice Côté

Show Details

Title: Principal Advisor, Data Science and Artificial Intelligence

Affiliation: Rio Tinto Aluminum, Arvida Research and Development Center

Quote: It is an honor to receive this award. TMS papers are best in class and have always been a reference in my work and our domain. For our paper to be recognized at the Light Metals level is definitely a highlight in my career

Other: "A Transient Model of the Anodic Current Distribution in an Aluminum Electrolysis Cell," Light Metals 2019

Contacts

The AP Technology™ team is committed to delivering innovative proven products in many critical fields to support increasing productivity and efficiency at your plant. Our technical platforms get upgraded with new technology bricks and allow adaptations of AP Technology™ solutions to best suit your own project configuration for unprecedented productivity and benchmark energy consumption.

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