AP Technology™ newsletter

Issue 20
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ap-technology.com

Rio Tinto

AP Technology™

Exceptional value delivery worldwide

En route to the future

Editorial

Technical excellence

The excellent technical results from all AP Technology™ platforms achieved in 2017 across the world at Rio Tinto Aluminium plants have confirmed those of 2016 and are a clear tribute to the talents of the teams developing and operating the technology at Rio Tinto Aluminium. Throughout 2017 the AP Technology™ team relentlessly proposed support to smelters by performing on-site missions to shoulder technical difficulties and by proposing and delivering advanced solutions for amperage creep or energy reduction to optimize their existing operations.

Technology bricks

2017 has also seen the technology centers stepping up the technical development and rolling out advanced technology bricks to further improve the performance and the robustness of both the high productivity and the low energy versions of the existing platforms, therefore bringing ever more efficient solutions to you for your plants and projects for the coming years.

Enhancements to our products ALPSYS and MESAL have kept flowing in so as to bring important process control, technical supervision and functionality innovations. Furthermore new tools such as RADAR have been rolled out and advanced data analytics modules have been implemented and supported through onsite workshops with the plants teams. Such innovations and new tools target processes efficiency and robustness via faster response to anomaly and easier detection of abnormal process patterns.

Philippe Bourdages
General manager, Technology
& Product Development

Towards smelter 4.0 solutions

Developments are taking place in progressing the Smelter 4.0 and amongst them, the industrial version of MAX, our autonomous anode transport vehicle, is currently under construction and will start to operate at Aluminium Dunkerque in 2018.

Current development led at Rio Tinto Aluminium continue to put AP Technology™ pots as the most promising technology platform for continuous improvement in existing plants as well as for bringing technology enhanced economic and environmental performance for new projects. AP Technology™ solutions keep on delivering more for the aluminum industry's current and future operators.

At the time of taking the helm of the Technology and Project Development team at Rio Tinto Aluminium, on behalf of the entire AP Technology™ team, I want to thank all our customers for your longstanding support and look forward to meeting you either at TMS or in your plant in the future.

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 website ap-technology.com where regular posts keep you informed of AP Technology™ activities.

TMS Light Metal Division rewards Olivier Martin's technical expertise.

This award recognizes an individual who has demonstrated outstanding long-term service to the light metals industry by consistently providing technical and/or operating knowledge that has enhanced the competitiveness of the industry. This year, Olivier Martin, Rio Tinto Aluminium Senior Technologist at the LRF, has been selected to receive this prestigious reward which highlights his tremendous expertise and contribution to the aluminium industry through his long career. This reward also contributes to AP Technology™ worldwide reputation and leadership.

Technology support for 21st century smelters

During the Arabal 2017 conference that took place in Muscat in November 2017, Rio Tinto had the privilege of organizing a pre-conference workshop on “Smelter Process and Production Optimization: Technology Contributions to Supporting Primary Aluminium Producers’ entry into the 21st Century”.

During the workshop attended by more than 80 people, Bernard Allais and Claude Ritter gave a presentation overviewing the performance of our industry before diving into the 21st century technology approach and explaining in detail the various smelter technology solutions that are becoming available.

Throughout the interactive workshop, participants were asked to participate in a live poll on how they viewed pace of innovation in the primary aluminium industry.

Most of the participants have plans to improve their smelters' performance in the future (61%) and a large majority (96%) are looking for a more robust approach to face the changing operating environment (raw materials, regulatory requirements, skills, etc.)

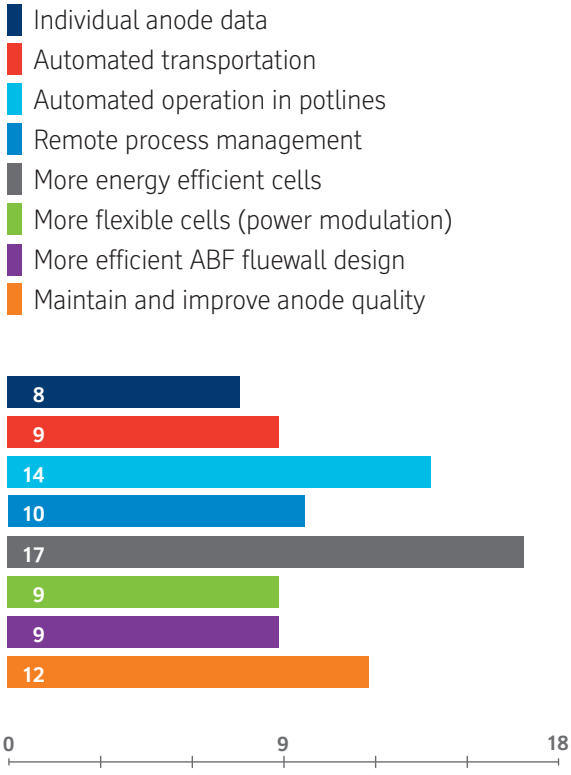
Most of the participants considered that the aluminium industry is innovating at a slower pace than the automotive industry and needs to accelerate (79%).

The largest challenges predicted for the coming five years are:

- Efficiency and operational robustness
- CAPEX and OPEX cost reduction
- Aluminium overproduction and Chinese environmental policy
- Availability of expertise

For the 32 participants, the top 3 AP Technology™ solutions that brought the most value to smelters were:

1 More energy efficient cells 16
2 Automated operation in potlines 14
3 Maintain and improve anode quality 12



That being said, all other solutions presented received nearly the same number of votes as the top 3 (ranging between 8 and 10 votes).

- Remote process management
- Automated transportation
- More flexible cells (power modulation)
- More efficient anode baking furnace fluewall design
- Individual anode data

The other topics highlighted by the participants were:

- Spent potline management
- Decrease of carbon consumption to reduce CO_2 emissions
- Improved tools to detect abnormalities and improve diagnosis
- Melt loss reduction at the casthouse

By the end of the workshop, the overall feedback from participants was very positive, with an average rating of 3.93/5 and a slew of positive comments:

“I learned a lot.”

“Keep doing such workshops. Very useful.”

“Not an easy topic to cover. Very good and informative presentation.”

News brief

The APXe aluminium smelter:

APXe technology is the latest AP Technology™ high productivity smelting solution developed by Rio Tinto. APXe technology combines:

- A very high productivity (505,000 Amps) leading to a production of 1,380 tonne per pot per year, 10 to 15% higher than the previous technologies,
- A very low specific energy consumption, of 12.0MWh/t Al, about 0.8MWh/t less than the competition.

Such very low specific energy consumption can translate into huge savings at the power generation step, compared to other technologies installed recently across the world.

Equipped with 360 pots, the APXe Aluminium smelter delivers its nominal capacity of 500,000tpa on a layout of only 65ha, and with a limited environmental footprint.

The APXe Aluminium smelter embeds the best and latest technologies available, and it is the benchmark for fluoride emissions and greenhouse gases emissions. It fulfills all environmental requirements of the European Union and the World Bank.

Item	APXe Aluminium smelter
Number of pots	360
Amperage (kA)	505
Specific energy consumption (MWh/t)	12.0
Annual production (kt/y)	500,000
Power requirement (MW)	750
Area (ha)	65
Fluoride emissions (kg F/t Al)	< 0.25

Mozal AP3XLE

Mozal and AP reached an agreement at the end of 2017 to implement at Mozal, in its two potlines, the AP3XLE Technology. Transition with the current pot design will start mid 2018 and follow the natural relining speed.

With the AP3XLE, Mozal will be able to reach 378kA and 13.0MWh/t in a near future.

AD415

With the last projects that had been implemented, the pots at Aluminium Dunkerque had reached their limits in term of operation stability and specific energy consumption with the potline amperage of 390kA.

However by implementing existing and validated AP Technology™ bricks such as magnetic compensation loop and new lining, there was an opportunity to further increase the potline amperage while remaining within the plant capabilities for the other workshops taking into account some optimisation in Anode production and Casting. The project AD415 was born. The modifications proposed in this project will bring the potline amperage up to 415kA and the specific energy consumption down to 12.8MWh/t. With this project, Aluminium Dunkerque production will be just under 300kt/pa representing a 40% increase from its earlier years.

The project was approved mi-2017 and the first new linings were started in H2-2017.

Alma AP44

In mid 2015, Rio Tinto began an AP44 trial at the Alma smelter to demonstrate the performance of this technology.

The eight AP44 pots were progressively started and have been in operation ever since. The purpose of this trial was not limited to the demonstration of the AP44 performance. It was also aimed at demonstrating the ability of this technology to operate at a lower amperage in order to be used as a future solution for creeping.

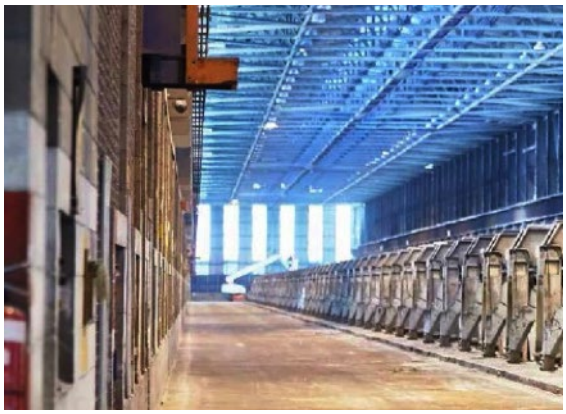
Today, the demonstration is made and the AP44 joins the AP Technology™ family with greenfield performances of 440kA and 13.3MWh/t.

Tomago aluminium: a benchmark in potlife performance at 255kA

Since it began operating in the early 1980's, Tomago Aluminium, located in New South Wales, Australia, has always been at the forefront of smelting productivity and efficiency.

With its upgrade to AP Technology™'s AP2X pot design in 2009, the plant has continued to push the robust AP18 technology to its limit.

Tomago Aluminium is now reaching a record amperage of 255kA across its three potlines, while at the same time achieving a benchmark potlife performance of 2,370 days.

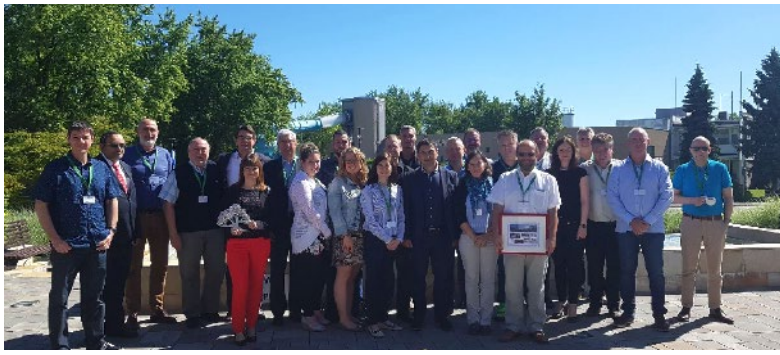


The 13th AP18 club conference

The 13th AP18 Club conference organized by the AP Technology™ team and hosted by TALUM Aluminij, welcomed 25 delegates from all AP18 smelters around the world, from the 6th to the 9th June 2017 in Ptuj, Slovenia.

The three-day event included numerous high-level presentations on smelter processes, operational challenges and HSE topics, giving the participants a unique opportunity to benchmark and exchange views, knowledge and experience on the various areas of the AP18 smelter.

The visit of the TALUM Aluminij smelter and the social activities organized thereafter also provided excellent platforms to network and connect. Thirty years after its initial conference (1987, in Becancour, Canada), the AP18 Club now represents nine smelters, totaling 2.4Mt of aluminium capacity per year. With 4,000 cells in their operations, the members of the AP18 Club confirmed the robustness of the AP18-AP2X smelting technology and the key avenues to take (production creeping, low energy consumption, low emissions, operational strength, etc.) to ensure their sites remain competitive in today's environment.



The IPH training catalogue

IPH, our technical training institute, has been serving the aluminium industry for more than two decades. Today the most exhaustive technical training catalogue covering all the skills needed in our industry is available online at:
ap-technology.com/SitePages/Products/iph.aspx

- Are you looking for training related to a very specific issue?
- Do you want to improve your teams' technical skills?
- Are you seeking the industry's most efficient and comprehensive training?

IPH training is your solution to develop core staff competencies.
Contact us for more information.

Managing emergency situations in modern potlines

An emergency situation in a potline holds the following characteristics:

- It is triggered by an unplanned event,
- It is potentially putting at risk several pots if not the complete potline,
- It requires immediate action to be taken within the few short hours following the incident.

To accurately manage these kinds of situations, it is paramount to be well-equipped and prepared in advance. The base of this preparation is built on having already answered two questions:

1. What is being done to avoid an emergency situation?
2. What do we do when we are in an emergency situation?

Avoiding emergency situations

For any given smelter, there are a handful of factors that "naturally" increase the risk of experiencing an emergency:

- The never ending quest for productivity improvement leads to leaner operations and a lower presence of manpower on site
- Skilled employees are leaving or being promoted and are consequently being replaced by less experienced individuals

To ensure these potential risks are properly managed, it is critical to create an extensive list of all events that could lead to an emergency situation, with a clear definition of what actions to take to prevent this emergency from occurring. In addition, this risk analysis should be reviewed periodically with the associated action plans, in particular each time the operation set point of the smelter has undergone a significant change.

Dealing with emergency situations

Despite our best efforts and even with detailed and preventative action plans, an emergency situation still may occur in a smelter. In the event of such a situation, the following items (identified prior in a risk analysis), must be deployed:

- The establishment of an emergency procedure,
- The identification, procurement and storage of any specific pieces of equipment needed,
- The regular and consistent training of involved employees on to execute the procedure and maintain/use the equipment.

It is a constant challenge to be ready to face any and all emergency situations that may arise during a smelter over the course of its life. Maintaining operations teams trained and keeping emergency procedures up to date however is a sure fire way to properly react and manage emergency situations in a controlled and effective way.

With their experience supporting many smelters in these kinds of emergency exercises, our AP Technology™ team can provide support to your smelters and improve their resilience to catastrophic events.

The latest development on open circuit protection

All aluminium smelters should have an open circuit protection system in place to detect occurrences of an open circuit in the potline and trigger line current tripping. The objective of such a device is to detect the event and consequently trip the line faster than manually pushing an emergency-stop button or calling the power plant to do so.

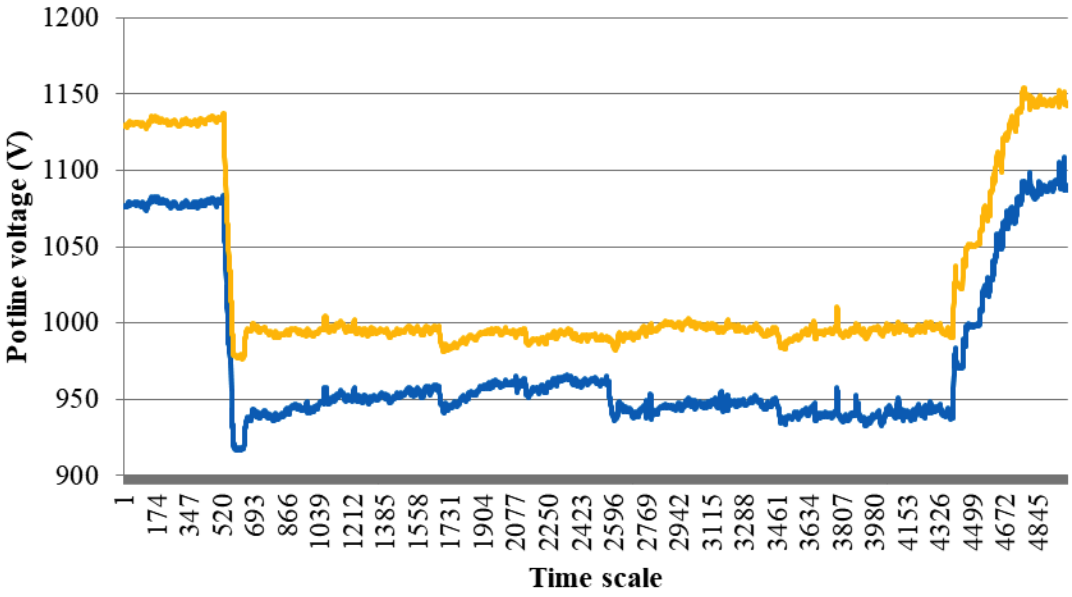
Based on years of experience dealing with this challenge, Rio Tinto has developed its own system: SURMEC.

In October 2017, we presented our latest development on open circuit detection at the ICSOBA conference.

The protection system settings must be fine-tuned according to the operating conditions of the potline (ie: the number of running pots and its status – normal operations, preheating, starting, ongoing anode effect – number of stopped pots, potline status and set point) and to the conditions of the power contract if applicable, for example: load shedding, frequency-dependent load adjustment, generating high magnitude of the current variation, etc.

To improve the real time alignment of SURMEC's settings to the potline's conditions, the AP Technology™ SURMEC team has developed and implemented a new auto-adaptive setting algorithm in the SURMEC system.

Potline voltage and open circuit auto-adaptive protection curve



This evolution is now embedded into all new SURMEC systems and available for all SURMEC users.

For more information, refer to the ICSOBA 2017 article:

or contact our sales team.

ALPSYS deployment methodology

Deployment on a live potline

The last ten years have seen new challenges for the ALPSYS engineering team and system start-up experts with the increasing number of potline modernization projects: ensure a safe deployment of the system on a live potline with a guarantee of no incidents/accidents and fully meeting the highest customer's expectations in terms of process performance, project planning, reliability and cost.

This ambitious objective has been achieved with the development of a standardized methodology with world-class practices in EHS management.

Three challenges for such revamping projects:

1. Minimize the impact on the existing infrastructure to reduce cost, work and time,
2. Manage the temporary loss of process control during the conversion to ALPSYS,
3. Mitigate risks due to electrical hazards and co-activity of ALPSYS installation with normal pot operations.

A method customized for each situation

The new equipment is adapted to each client's specifics, in order to minimize the impact on the existing infrastructure to reduce cost, work and time. In Dunkerque: new potmicros were packaged in a plug & play cabinet. Replacement on a pot was done in less than 10 min, allowing a rate of 33 pots replaced per day.

Existing infrastructure

Are you willing to replace your pot control system that becomes obsolete?

Are you wondering what are the benefits ALPSYS can bring for your potline if you implement it?

We can set up a trial on a few pots to demonstrate ALPSYS's efficiency and adaptability to your pot technology. Contact our sales team for more information.

RADAR process intelligence

Our new Business Intelligence solution called RADAR (Reduction ALPSYS Data Analysis and Reporting) incorporates the knowledge and experience acquired during more than a century of designing, building, running and supporting smelters. It enables you to manage your reduction operations and production, by analyzing regulation process & operation data.

RADAR: a Business Intelligence solution used to:

- Analyse pot regulation
- Spread best practises all over the world

RADAR modular approach

- Core set of tools part of ALPSYS V15
- Plant modifiable & customizable
- Adaptable to existing regulation systems

RADAR business solution

RADAR is not only an IT solution. It integrates business processes and best practices defined and optimized by one of the world's leading aluminium plant operators.

RADAR flexibility to define your own business intelligence system

As RADAR is a fully open-solution, your teams can modify and customize absolutely everything in your application: starting from colors of your graphs, to all formulas, by the creation of dashboards and insertion of all data in your system.

RADAR workshops

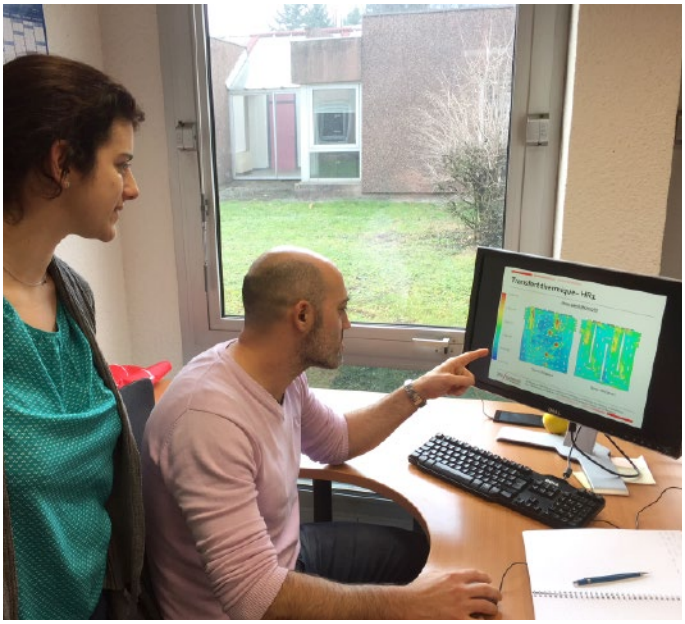
In 2017, RADAR workshops were organised at Tomago, Dunkerque and Hillside to train the local process and IT teams on the advance use of the system. Using this opportunity, both teams were able to configure their own dashboards during the workshop, with the customised approach they were looking for.

Modelling suite for anode baking process and furnace design

Computer-aided modelling has become a critical tool for production facilities and equipment design for most of the industry. We have been developing modelling tools since more than 20 years. Those tools were originally used for research and development activities in the reduction cells field. This expertise has been deployed towards the other parts of the smelters and particularly in the anode baking area. It is now a fully integrated part of the design and optimization process.

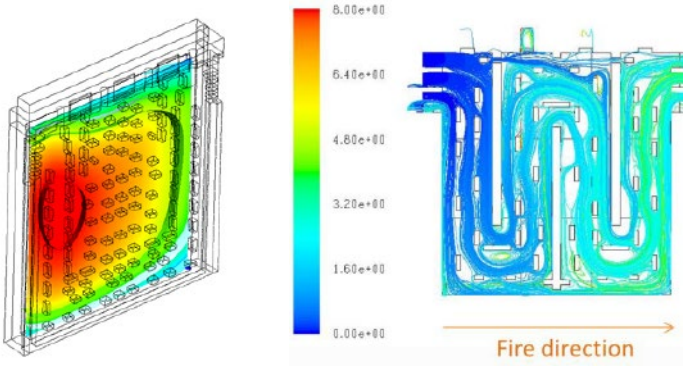
Modelling is indeed very pertinent for anode baking furnace design where modification and optimization are a demanding and complex process to manage. The duration of tests realized in a production environment makes it often difficult to draw firm conclusions and/or to isolate the impact of one factor on the overall furnace performance.

Specific models developed and tested on real cases are now integrated at various stages of the design process.



The main applications are:

- Adjustment of baking parameters in the context of fire cycle change and/or anode size modifications in order to maintain baking quality;
- Quantification of sensitivity to cold degassing for process safety;
- Fluewall internal design with flow repartition optimization, cold zones avoidance and pressure drop calculation (to decrease demand on FTC and avoid degassing front runaway);
- Gas injection optimization to decrease emissions (NOx, unburned CH4, etc.).



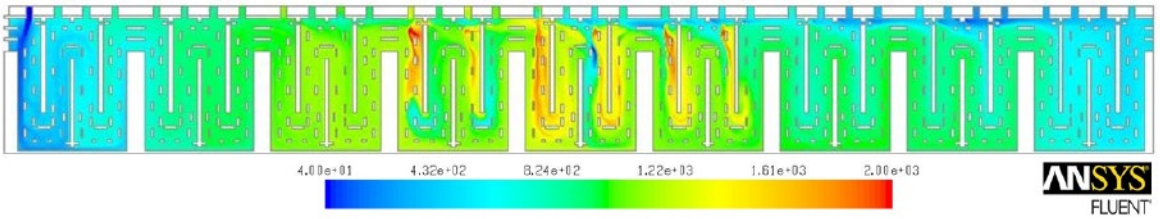
The portfolio of available modelling tools goes from agile 1D thermal model for quick and cost efficient study to 3D full transient model of the complete fire for more in depth investigation.

Each case being unique, a combination of several models is often the best option to answer the questions. Coupled with 50 years of experience in refractory design and anode baking furnace operation, it allows our experts to support running plants in their various projects.

“With more than 50 years of experience in furnace design and the latest CFD* modeling tools, AP Technology™ offers the most complete modeling suite for baking process and design optimization.”

* Computational Fluid Dynamics

Should you have any questions on fire cycle optimisation, process issues, training for your teams, ABF heightening, ABF refurbishment … do not hesitate to contact us!



Carbon News Brief

Aluminum of Greece

AP Technology™ expertise in casing design to secure anode baking for the coming decades

Aluminum of Greece anode baking furnace was built in 1964 and extended in the seventies. The 78 sections furnace will face significant repairs in the coming few years as the central casing walls will be changed and the insulation renovated. Thanks to its technical expertise and the experience acquired in similar project (Trimet smelter in St-Jean-de-Maurienne) AP Technology™ team supports AoG from the preliminary study to the detailed engineering and on-site support during execution in order to safely and successfully realize these majors repairs without shutting down the entire furnace.

Qatalum

Baffleless fluewalls condition review after 140 round of fires

Qatalum operates since 2010 two AP Technology™ furnaces with 66 and 50 sections respectively. The nine fluewalls per section furnaces are both equipped with the baffleless fluewall technology. AP Technology™ experts visited Qatalum at the end of 2017 to review the refractory condition and the furnace performance. Thanks to a fully mastered operation and refractory maintenance, the first generation fluewalls are now successfully reaching seven years of operation (i.e. more than 140 fire cycles) while allowing very good performances in terms of gas consumption and air flow required from the fume treatment center. The flatness of the top surface of the furnace (no raising or sinking) and the straightness of the headwalls and fluewalls are a positive sign for the final lifetime to be achieved! Qatalum has proactively started the second generation of baffleless fluewalls implementation with 20% of the fluewalls already changed.

Additional ABF news from around the world

Full rebuild without production stoppage successfully ended

In 2017, our team supported the final stage of the full refractory rebuilt of two baking furnaces. This ends a several year project where the baking furnaces were raised and refurbished with the help of AP Technology™ expertise in civil engineering, refractory design and fluewall modelling. The project has been successfully realized without any total production stoppage thanks to an innovative fire operation on one casing originally proposed by AP Technology™ operation experts. After 25 years of operation, the AP Technology™ headwalls were demolished to allow the erection of new refractory. The existing casing have has been reused and is ready for a new 25 years mandate!

Performance review after four years of operation

Our AP Technology™ experts had the opportunity in 2017 to assess the operation performance of one of our latest anode baking furnace design. This furnace, is the most productive one ever built. The on-site technical and performance review allows to successfully observe that even after some years of operation and thanks to the rigorous operation and maintenance practices, headwalls and flue walls stays in very good condition after more than 60 fire cycles. This allows the furnace operation team to deliver baking quality as per target with a very low energy consumption (below 1.7GJ/t).

MESAL™ mobility extension

MESAL™ mobile KPI

The MESAL™ Mobile KPI application allows access to the MES KPI database of external systems such as ALPSYS or other applications (ERP, SCADA, Historian, other MES systems, etc.). This application offers a single point of access to a plant KPI repository to provide the plant management team with a global view of production and operations.

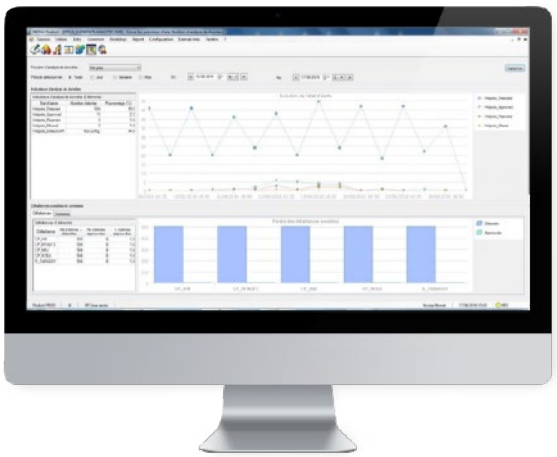
MESAL™ mobile shift log

The MESAL™ Mobile Shift Log is used by the team supervisor during the shift, reducing the time spent in front of his computer. It provides on the shop floor instructions and production information to promptly react and amend any deviation from the plan. It is also used to complete throughout the shift the logbook directly from the shop floor.

MESAL™ PPDA = plant process data analytics

PPDA, a new MESAL™ module has been created to accompany Big Data deployment in the plants. This module provides some connectors with the various IT systems (ERP, SCADA, Historian, other MES systems, etc.), runs the predictive functions developed by R&D department, and displays the results of the functions in the MESAL™ Shift Log.

With the PPDA module, operation people have access in real time to the alerts generated by the predictive functions, can acknowledge or reject these alerts to increase the efficiency of the functions and monitor their global performance with relevant KPI such as detection rate.



A new MESAL site

MESAL™ has been chosen by ALBA to manage the new Carbon & GTC's installations in the field of the ALBA Line 6 project. This MESAL™ Solution will embed all the new features from Version 4.X versions.

Technology bricks

The scale-up test platform at the LRF (Saint-Jean-de-Maurienne, France) with three of the latest pots operating presents an opportunity for the development of new technology bricks in an industrial environment under controlled conditions. The technology teams have set-up a multi-year program to continue to develop on these pots the next generation of technology bricks to improve the productivity and the power efficiency of the AP Technology™ platforms operating under various conditions around the world.

The development of the technology bricks for the pots covers the following fields:

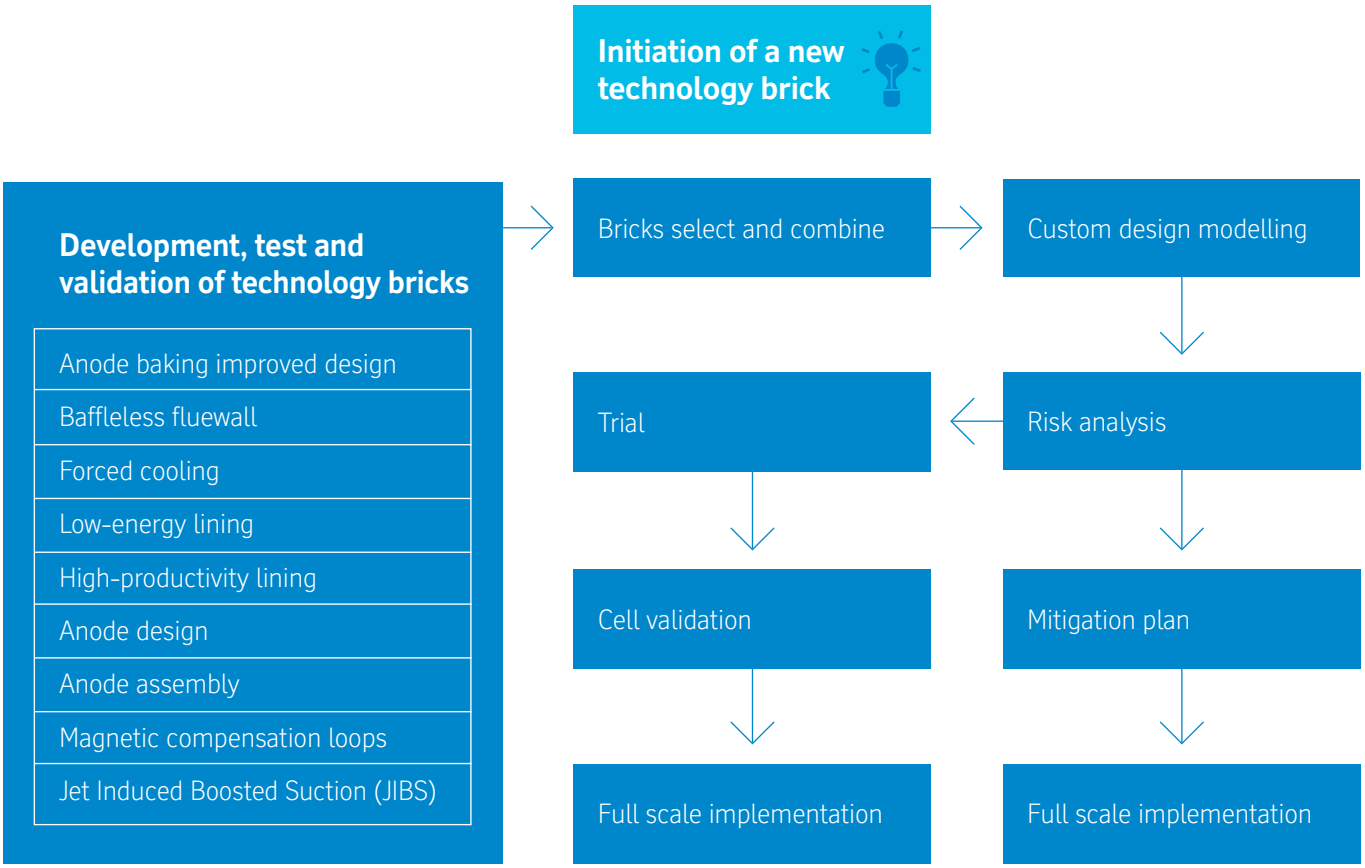
- Electrolysis process: reduction of electrical resistance, operation at low ACD, anode and cathode design and behavior
- Robustness of operation: design of the pot lining, operation at various set points
- Process control and measurements: modification to process control, automatic measurements, advance analytics and data analysis
- Modelling: pot stability, alumina dissolution
- Amperage creep and productivity improvement: automatic operations and logistics

As they become validated on the LRF test platform, these technology bricks then moved to implementation on a trial basis in the plants in order to confirm their performances before being rolled out.

In the field of anode baking furnace, the technology teams have launched a development program including trials performed on baking furnaces around the world to allow to reach similar results:

- Reduced energy consumptions
- Reduced environmental impact
- Longer refractory life
- Reduced refractory cost

Such technology bricks once fully demonstrated join the tool box of the technology team and can become combined with already existing ones to design a new solution adapted to a smelter specific site and energy conditions.



TMS 2018

Phoenix, Arizona

At the TMS Light Metals Conference in Phoenix, 11 March – 15 March 2018, Rio Tinto Aluminium will present or sponsor the following presentations:

In Reduction, there are four presentations: one on Spike detection using advanced analytic and data analysis about a new tool based on anode current live measurement combined with machine learning that has been developed and tested and which is an efficient way of detecting many of these spikes, usually with a few days of anticipation. Another one is about Alucell, a unique suite of models to optimize pot design and performance which makes it possible to model transient MHD instabilities, alumina dissolution and distribution within the pot, and the coupling between thermo-electric balance and MHD flow. A third one is about the results achieved after 8 years of operation at high amperage low energy cell at the LRF, France highlighting the management of heat loss and the mastery of low anode cathode distance operation. The fourth one on the AP44 at Alma, Canada where a major step in amperage increase was undertaken with the development of the AP44 technology operating at more than 440kA.

In Carbon, our presentation on anode is entitled 3D transient modelling of a complete fire line for Anode Baking Furnace design and optimization and explain how advanced Computational Fluid Dynamics models developed for a complete fire line helps to better understand the impact of different parameters and therefore improve furnace design, performance and anode quality including for modification of existing furnaces required to support amperage creep.

In Environment, we present two topics: one in collaboration with UQAC and Aluminerie Alouette on a New approach for quantification of perfluorocarbon resulting from high voltage anode effects in aluminium smelters where new approaches, including non-linear models, were used to estimate the emissions of PFC during individual high voltage anode effect and the potential of those quantification methodologies were evaluated by extrapolating results for significant operation periods. A second one in collaboration with UQAC, LMRC, IAI and Rusal on the Evaluation of time consistency when quantifying emissions of perfluorocarbons resulting from low voltage anode effects where following the novel methodology proposed to estimate the annual LVAE emissions by Marks & Nunez, the total respective PFC emissions resulting from high and low voltage anode effects were calculated based on historical data supplied by a select set of aluminum smelters, allowing evaluation of the potential impact of LVAE on the total amount of PFCs reported.

In Casting, we present in collaboration with Pyrotek on RFM heated pin development and industrial evolution and what were the main steps for the development of the new RFM heated pin recently developed and patented and their evaluation at industrial scale at Rio Tinto.

Additional news over 2017 include:

At TMS 2017, we presented in the plenary session Primary aluminium smelting on the move where we showed how technology contributes to maintaining plant competitiveness by focusing on creep and incremental performance improvements, by nurturing highly qualified technical experts, by setting-up Operational & Process Excellence Centers, by making use of Data Analytics and bringing Automation into the workshops.

In May, at the occasion of the *6e édition du Salon La Vallée de l'aluminium en affaires* in Saguenay, Canada we gave a presentation where we outlined the current challenges for the primary aluminium industry proposed that the use of new sensors and new analytics methods would be the next wave of productivity improvement and illustrated that through few examples across the main processes in the smelters.

At the ICSOBA Conference in October in Hanover, Germany the Technology team presented a few papers and in particular one on Potline Open Circuit Auto-Adaptive Protection.

We also participated at the 21st Arabal Conference held in Muscat, Oman in November where we held a pre-conference workshop on Smelter Process and Production Optimization: Technology Contributions to Supporting Primary Aluminium Producers' entry into the 21st Century.

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The AP Technology™ team is committed to providing seamless support and groundbreaking solutions to ramp-up your smelter production and drive down your power consumption. Demonstrated by our AP40LE/AP40 and APXe/AP60 platforms, there are AP Technology™ solutions adapted to your greenfield or creep project configuration for unprecedented productivity and benchmark energy consumption.

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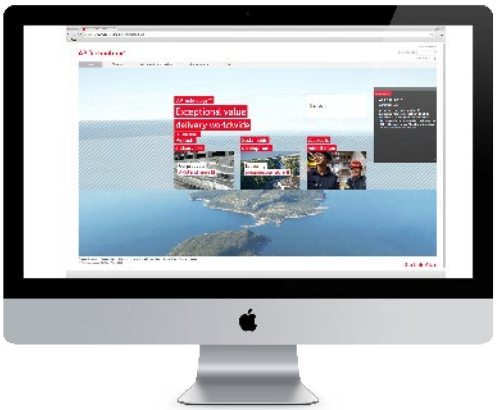

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