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# AP Technology™

Exceptional value delivery worldwide

Rio Tinto Alcan


# AP60 Jonquière: Well done!

In August 2014, the Arvida Aluminium Smelter, AP60 Technology Centre passed Rio Tinto Alcan's rigorous internal certification confirming the technology's effectiveness and reliability.

The performance test of the installed AP60 technology was conducted over a 30-day period, with excellent results, as summarised in the table below. The test included a reinforced process and production follow-up to assess the technology's full potential.

The performance test results were excellent:

## AP60 performance test results

| Key indicator | Result |
|---|---|
| Metal production (kg/p/d) | 4,407 |
| Amperage (kA) | 570.7 |
| Current efficiency (%) | 95.9 |
| SEC (kWh/t Al)* | 13,090 |
| Anode effect frequency (AE/p/d) | 0.02 |
| Roof vent fluoride emissions (kg F/t Al) | 0.21 |

* SEC computed for an industrial plant

In parallel to the technological validation, some pots equipped with a booster group are operating beyond potline amperage. These AP60 pots will run at an increased amperage to develop the next technological step in industrial conditions and to validate new benchmark in the aluminium industry.

**The amperage of 600kA was reached on 22 January 2015, one month ahead of schedule.**

In addition to the excellent pot performance, the test showed outstanding environmental results. The fluoride emission level of 0.21kg F/t Al is the result of the innovative design of the pot gas collection system inside the superstructure, specific pot tightness improvements compared with previous pot generations, the very stable pot behaviour and of course high work quality. The anode effect frequency decreased to 0.02AE/p/d during the performance test as the process and operation teams adjusted to operating at full scale and as the pot fine-tuning advanced.

"The performance of the AP60 cells monitored over the past 12 months represents an all-time best in Rio Tinto Alcan's aluminium smelting technology. Optimised frameworks such as busbars, shell and superstructure allow for a very high level of cost effectiveness compared with previous cell generations, by ensuring benchmark productivity (production of 4,400kg/cell/day for AP60), low energy consumption and record low emissions," explained Claude Vanvoren, Vice President Technology and Research and Development, Rio Tinto Alcan.

*Cover picture: Kitimat potline*

# Editorial

## AP60 technology is a reality

**Vincent Christ**
*Vice president, Technology R&D, Equipment Sales & Services and Carbon products*

After one year of operation, the AP60 technology solution installed at Arvida Technological Centre in Jonquière, Canada, shows outstanding technical results. The performances have been above expectations on all counts and the threshold of 600kA was reached in January earlier this year. APXe, the low energy version of AP60 technology operating at the Laboratoire de Recherche des Fabrications (LRF) in France, achieved its targeted specific energy consumption of 12.0MWh/t at amperage above 500kA, successfully delivering the promised step change in energy reduction.

In 2014 we also completed the final ramp-up of 1.5 million tpa at our clients' new AP37 and AP36 smelters in Saudi Arabia and India. In November 2014 Sohar Aluminium became the first smelter to convert to AP40 technology and today Rio Tinto Alcan Kitimat Modernisation Project is mobilising for the final steps towards first hot metal.

AP Technology™ products ALPSYS and MESAL have been installed at new customer sites with constant effort going into important innovations in both functionalities and product characteristics. The fully automated anode change operations at AP60 Jonquière has been proven.

Work continues to further develop new technology bricks to allow fast and safe pot reengineering with enhanced performances for amperage creep or energy reduction on the existing AP18, AP30 and AP60 platforms.

While 2014 has been a challenging time for the aluminium industry, AP Technology™ team remains committed to supporting global customers by delivering advanced solutions to optimise their operations and ensure their success. Please enjoy reading the interesting updates and news in the following pages and stay tuned for another exciting year of AP Technology!

# Routes to excellence

Aluminium smelters worldwide are working hard to keep or improve their position on the industry cost curve. To lower expenditures in $/t, a plant can focus on costs, overall production levels or both. One option is to launch broad-based savings initiatives. While such programmes are effective, their impact on the smelter's relative position on the cost curve tends to remain limited.

Past experience has demonstrated that one of the best ways to strengthen competitiveness is to improve pot performances by implementing a pot modernisation programme. Indeed, two smelters that initially used the same pot technology can display very different targeted pot performance, depending on factors such as:

- Energy cost and availability
- Bottlenecks in the carbon department
- Remaining capacities in the gas treatment center, substation and carbon department

The AP Technology™ team is able to support any smelter in the development of a clear vision of its technical potential using our latest demonstrated technology bricks, including:

- Forced cooling
- Low-energy lining
- High-productivity lining
- Magnetic compensation loops
- Jet Induced Boosted Suction (JIBS)

Such technology bricks, associated with our simulation tools, combined with our extensive experience in assembling such elements and in supporting our clients from the detailed engineering stage to the operation of the solution, are key to your success.

On this journey to excellence, vision and goals are vital. Equally important is ensuring they are supported and managed. Some changes, such as lining design, take years to fully implement. Properly managing the transition from one technical design to the next is essential. The AP Technology™ team brings you the expertise they have developed over the last decades through their numerous successful creeping projects.

We have the solutions that will make your improvement dreams come true.

# Kitimat

## The final countdown

Kitimat site

At Kitimat, British Columbia, the new 384-pot potline, installed in four separate rooms and hosting the latest AP40 technology at 405kA and 13,150kWh/t, is gearing up for action.

With an operation readiness plan established before the project kick-off and updated throughout the construction phase, the Kitimat plant is ready for the challenge of stopping the remaining Soderberg lines and starting the new AP40 line without any additional external permanent manpower.

To support the transition over the coming months, the AP Technology™ commissioning and start-up team is mobilising on site to safely support the local teams during the challenging months ahead.

We wish them all a safe and very successful start-up.

# Fully operational Ma'aden Aluminium Smelter

## Key to a completely integrated supply chain

Ma'aden smelter site

The Saudi Arabian Mining Company (Ma'aden) was formed by Royal decree in 1997, in keeping with the mandate of the third pillar of the Saudi economy, which aimed to facilitate the development of the Kingdom of Saudi Arabia's mineral resources.

With benchmark safety standards and a 65% in-house-trained local Saudi workforce, Ma'aden Aluminium, the joint venture developed between Ma'aden and Alcoa, successfully achieved first hot metal at the smelter on its target date of 12 December 2012. No lost-time accidents were recorded. Today, Ma'aden has a fully integrated supply chain, including a bauxite mine, refinery, smelter and rolling mill.

The smelter uses AP37 technology across its two potlines to produce 740,000 tonnes per year of aluminium and is now fully operational, while the mine, refinery and rolling mill are ramping up operations.

The successful completion of the smelter's 720 pot start-up was celebrated in July 2014, and the smelter has since enjoyed excellent technical performances.

Ma'aden Aluminium will complete the ramp-up of all its facilities in 2015 to become fully operational, with a focus on safety and maintaining operational excellence and quality across its fully integrated facility.

# The longest contract in the history of AP technology

The contract with NALCO, the longest ever with a company totally independent of Aluminium Pechiney, is still in force, more than 30 years after it was initially signed, following successive renewals.

In 1975 PUK (as Pechiney was known then) was informed that the Indian Government intended to begin producing aluminium in the State of Orissa (now Odisha), which had rich bauxite and coal deposits.

The contract was signed on 9 January 1981 between Bharat Aluminium Company, or BALCO (Bharat means India), and PUK. It covered the entire range of operations from the bauxite mines through to the production of ingots, making it the most wide-ranging contract with a third-party customer in terms of its field of application.

Odisha was one of the remotest states in India, and the vast project also aimed to promote local development. The government later set up a public company dedicated to the project, which was independent of BALCO. It was named NALCO (National Aluminium Company) and had its head office in Bhubaneswar, the capital of Odisha. The contract was reassigned to NALCO.

## 1 – NALCO at a glance

**A – Situation:**
The bauxite deposits are located at Damanjodi in a beautiful plateau region. The 1,000 metre altitude is high enough to avoid extreme heat, a major advantage for both the staff and the machines.

Some of the alumina produced is sent by train to Visakhapatnam in the Bay of Bengal to be exported.

The smelter and captive power plant are situated close to coal deposits at Angul, a small rural town in a rice-growing plain about 130 kilometres from the sea. The main raw materials are carried there by train.

*Damanjodi: Bauxite Mine*

*Damanjodi: Alumina Plant*

*NALCO port installations at Visakhapatnam*

**B – Capacity:**
NALCO was built and developed in three stages, each involving essentially the same technologies with a few improvements.

| Capacity | | | |
|---|---|---|---|
| Facility | Originally | After expansion 1 | After expansion 2* |
| Bauxite mines | 2,400,000t | 4,800,000t | 6,300,000t |
| Alumina refinery | 800,000t | 1,575,000t | 2,100,000t |
| Smelter | 218,000t | 345,000t | 460,000t |
| Captive power plant | 600MW | 960MW | 1,200MW |

* In progress

## 2 – The challenges of the Angul plant at the time of the project in the 80s:

The project had to face a number of challenges, including the following:

**Size and complexity:**
The Angul plant is a sister plant to Tomago (a smelter established in Australia in the early 80s), the most modern at the time, with two potlines of 240 AP18 pots, a complete anode sector with a paste plant, baking furnaces and a rodding area, plus a casthouse equipped with two ingot lines and two of the latest-generation Properzi rod machines. It represented a huge increase in terms of size, complexity and equipment automation, as well as optimisation of the installations in comparison with the Korba (BALCO) plant, from which most of the NALCO managers were drawn.

For the operators, all local, it meant leaping into a new world.

**Communication:**
The plant was built and started up without any real operating outside phone line, telex or fax. Telephoning to France meant going to Bhubaneswar, a round trip of about six hours by car.

Communication within the plant was also complicated due to the many different languages and dialects spoken by the staff.

**Red tape:**
At the time, management of the public sector in India was characterised by a certain amount of administrative red tape, which could make life at the plant difficult.

**Total absence of small local firms:**
There were no small firms in the Angul region able to provide quality subcontracted services, without which the life of a smelter such as this is very difficult.

## 3 – Engineering and construction:

For AP technology sales, the project was ably supervised from Voreppe right from the start and up until 1990, well beyond the end of construction of phase 1.

Engineering India Limited (EIL) was commissioned with the engineering and construction aspects of NALCO plants. The engineering work was carried out in Delhi, with the support of an AP project manager sent there in July 1982. He was the first in a long line of “AP experts” involved in the NALCO project.

In 1984 the first AP team arrived on the smelter site. They had to take a philosophical approach so as to adapt to life at NALCO Nagar.

Construction was carried out according to local custom, that is, with very few machines. The construction work was long and difficult to complete, requiring great determination from all the parties concerned and from the AP experts, but the outcome was that its quality was never challenged. The linings, for instance, had some of the longest lifespans in their category in spite of considerable ill treatment in the following years. This is all to the credit of EIL, the NALCO construction teams, AP technology and its experts.

*Angul: Captive Power Plant (CPP)*

*Angul: Smelter*

**4 – Operations:**

NALCO's teams were trained in 1985 and 1986 essentially at Vlissingen (Netherland) and at Tomago (Australia). The courses went well, the trainees being well received by the plants and making a good impression on their hosts.

The first pot was started up in potline 1 on 28 March 1987 but it was only in May 1993 that an operating rate of nearly 90% was achieved.

The first few years were challenging. In spite of the early difficulties, NALCO and its environment slowly began to ramp up, improving its performance and growing steadily. Potline 3 started in 2002 without any major hitch. In the early 2000s NALCO's three potlines were operating at about 183kA with current efficiencies of nearly 94% and an excellent lining service life of roughly 100 months.

Apart from a few periods of tension, these results were achieved steadily thanks to the confident, friendly relations built up between NALCO and AP staff. They represent a great success for both companies.

*Courtesy of IHA – Marc de Zélicourt*
*(Translated from the French and edited by Aluminium Pechiney)*

# Updates from around the globe

*Boyne Smelter*

## BSL

### The magnetic compensation loop delivers

As mentioned previously, Boyne Smelter Ltd in Queensland, Australia, has installed an AP compensation loop on its potline 2, with a view to improving the magnetic stability of its Sumitomo pots to unlock further amperage increases.

One year after it was energised, the compensation loop has successfully stabilised the pots, allowing an amperage creep of over 16kA (equivalent to more than 7% in productivity), while maintaining – and in some cases improving – all other technical KPIs.

Updates from around the globe

# Hindalco

## Aditya and Mahan AP36 smelters in operation

In India, the Aditya and Mahan smelters have continued adding pots throughout the year. However, coal availability is posing a significant challenge for ongoing pot ramp-up at the growing Mahan and Aditya smelters.

There are currently 230 pots in operation in Mahan and 152 pots in operation at the Aditya smelter. Both smelters are operating at 363-365kA. Each smelter will eventually consists of 360 pots of AP36 technology powered by adjacent coal-fired captive power plants.

The AP Technology™ anode baking furnaces of both units have also been commissioned and Aditya has begun supplying baked anodes to Hindalco's neighbouring smelter in Hirakud.

*Aditya*

# Sohar Aluminium

## Full conversion to AP40 technology

*Sohar Aluminium*

Sohar Aluminium, in operation since 2008 with AP35 technology, reached an important milestone in November 2014: all of its pots were converted to the AP40 design, unlocking creeping potential of the smelter up to 400,000 tonnes of production (more than 25,000 tonnes above 2013 production levels).

The next two years will see further modernisations and improvements in the plant workshops to accompany the amperage increase, such as installing a compensating loop, replacing the anode baking furnace flue walls and adding a vacuum to the vibroformer.

The AP Technology™ team will actively continue to support Sohar Aluminium in the implementation of the new equipment and during the transition phases to ensure the success of the project.

# Alcoa Deschambault

## Upgrading its AP anode baking furnace

After more than 20 years of operation, Aluminerie de Deschambault is implementing the latest AP Technology™ improvements to renovate its two anode baking furnaces and increase their capacity.

The renovation involves raising the concrete casing and increasing the pit width to accommodate the baking of larger anodes, which will meet the needs of the reduction process.

The first bay of the first furnace was successfully rebuilt in 2014 and the second bay rebuild is scheduled for the first half of 2015.

# EMAL

## New energy consumption benchmark achieved by the AP Technology™ anode baking furnace at EGA Taweelah

The commissioning of the AP Technology™ Anode Baking Furnace at EGA Taweelah (EMAL) was completed in 2014.

With four fires and 68 sections, the furnace has a benchmark capacity of 330kt/year of baked anodes.

The technical performance evaluation showed that another benchmark was set by the furnace as it achieved an energy consumption as low as 1.53GJ/tonne.

This is the result of AP design efficiency, AP process control principles and the excellent standard of operations maintained by the EGA teams.

# Sustainable solutions

## Assessment of GHG emissions

**AP Technology™ deploys a wide range of sustainable solutions and services to its clients. Below is a focus on the assessment of Green House Gases (GHG) emissions in a smelter. Different approaches may be used to evaluate GHG emissions in accordance with IAI standards.**

*Technology specific slope and overvoltage coefficients for the calculation of PFC emissions per tonne aluminium from AE process data*

| Technology [a] | Slope coefficient [b,c] [(kg $_{PFC}$/$t_{Al}$) / (AE-Mins/cell-day)] | | Overvoltage coefficient [b,c,d,e] [(kg $_{CF4}$/$t_{Al}$) / (mV)] | | Weight fraction $C_2F_6/CF_4$ | |
|---|---|---|---|---|---|---|
| | $S_{CF4}$ | Uncertainty (±%) | OVC | Uncertainty (±%) | $F_{C2F6/CF4}$ | Uncertainty (±%) |
| CWPB | 0.143 | 6 | 1.16 | 24 | 0.121 | 11 |
| SWPB | 0.272 | 15 | 3.65 | 43 | 0.252 | 23 |
| VSS | 0.092 | 17 | NR | NR | 0.053 | 15 |
| HSS | 0.099 | 44 | NR | NR | 0.085 | 48 |

a. Centre Worked Prebake (CWPB), Side Worked Prebake (SWPB), Vertical Stud Søderberg (VSS), Horizontal Stud Søderberg (HSS).
b. Source: Measurements reported to IAI, US EPA sponsored measurements and multiple site measurements.
c. Embedded in each Slope and Overvoltage coefficient is an asumed ernissions collection efficiency as follows: CWPB 98%, SWPB 90%, VSS 85%, HSS 90%. These collection efficiencies have been assumed based on measured PFC collection fractions, measured fluoride collection efficiencies and expert opinion.
d. The noted coefficients reflect measurements made at some facilities recording positive overvoltage and others recording algebraic overvoltage. No robust relationship has yet been established between positive and algebraic overvoltage. Positive overvoltage should provide a better correlation with PFC emissions than algebraic overvoltage.
e. Overvoltage coefficients are not relevant (NR) to VSS and HSS technologies.

The Tier 2 approach is used when the plant/smelter does not have all the process data and, more importantly, when it has not measured its own Perfluorocarbon (PFC) emission factors. The standard Tier 2 coefficients, valid for a block of technologies (CWPB, SWPB, VSS, HSS), are provided in the IAI table above.

The Tier 3 approach is used when these data exist and are known to the plant.

With such a method the CF4 emissions are considered to be proportional either to the anode effect positive over voltage and current efficiency (over voltage method) or to the frequency and duration of the anode effects (slope method). In both cases the C2F6 emissions are considered to be a fraction of the CF4 emissions. The slope method is becoming preponderant in the industry today.

Coefficients are determined by means of a measurement campaign at the gas treatment centre inlet using Fourier transform infra-red (FTIR) spectroscopy.

The Tier 2 approach is correct and accepted but may lead to an overestimation of the PFC emission. In Europe the EUETS (EU Emissions Trading System) deployment requires that the plant emission coefficients be reassessed every three years. These coefficients are used to establish the yearly inventory of GHG emissions, which determines the amount the plant must pay for these emissions. This is why some smelters are interested in a measurement campaign and its subsequent data analysis to determine their specific Tier 3 coefficients.

The LRF in France and ARDC in Québec, Rio Tinto Alcan's two R&D centres, are now equipped with measurement equipment and are able, on request, to undertake the measurement campaign and subsequent data analysis to determine the Tier 3 emission factors.

# ALPSYS @ ALBA

## Having launched the ALPSYS upgrade of Line 5, Line 4 and Line 3 in 2013, ALBA decided in 2014 to also implement the ALPSYS upgrade on Lines 1 and 2.

The overall ALPSYS project is now well advanced:

- The switching of Lines 4 and 5 to the latest ALPSYS version took place at the beginning of 2015.
- The factory acceptance test of Line 1, 2 and 3 systems was successfully performed in December 2014.

With this ALPSYS project, ALBA will be operating all its potlines with the same ALPSYS system within a few months. ALBA will be able to improve pot performance and efficiency via the use of the latest ALPSYS developments incorporated into the installed system. Synergies will also be generated between the process teams of ALBA's different potlines, creating opportunities to share technical resources and standardise procedures across the entire plant, despite the differences existing between five potlines operating three different pot technologies.

With this upgrade, ALBA will become the largest smelter fully operating on ALPSYS systems.

# ALPSYS

## More than a product: an array of opportunities!

Over the last 15 years, the ALPSYS team has shown unwavering determination in developing the product in order to deliver ongoing performance improvement opportunities in process and operation.

On the heels of the R&D work performed over the past few years, 2014 saw the completion and validation of our latest alumina control algorithm. With the new version of the alumina feed procedure including the high/low frequency instability treatment, the improved tracking conditions and a broadened alumina control range on unstable pots, the ALPSYS system is providing concrete and robust solutions to sustain optimal pot operation in increasingly demanding operating conditions, typically found in plants that are lowering their ACD.

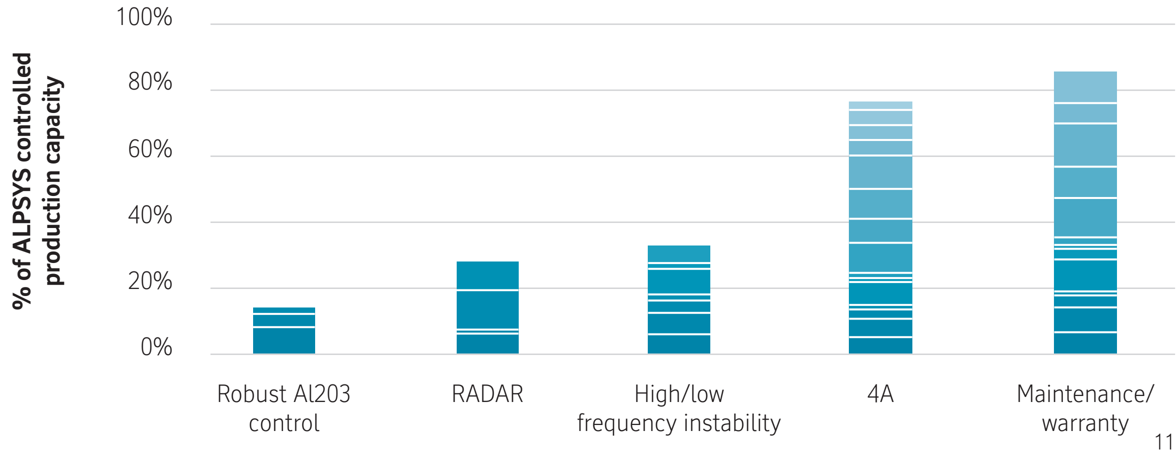
Alongside the development of control procedures, 2014 was also a very successful year in consolidating our active customer base. More than 25 potlines can now benefit from these improvements through evolution services provided to plants running any version of ALPSYS.

The second release of RADAR, our process intelligence solution, has now been installed in two plants; two others will start using it in 2015.

To address the growing challenges of ageing IT equipment and operating systems faced by some of our clients, we can now propose a range of upgrade options that provide a flexible approach to hardware obsolescence without the need to launch a complete system upgrade.

The plants under maintenance have also relied on the support of our AP Technology™ partner RTA Alesa for the repair of, and the supply of spare parts for, ALPSYS parts and equipment.

**Plants benefit from support and key developments**



# MESAL™

## Breaking news

*Kitimat*

## MESAL™ 4.0

MESAL™ 4.0 is now fully deployed at the Kitimat smelter, British Columbia. The last key user training session was held in late January 2015. MESAL™ is now up and running, ready for Day 1 of the commissioning phase of each of the smelter shops. This will bring strong technical monitoring to the teams in charge of the smelter ramp-up.

## Operational Excellence for Reduction

In early January Dunkerque started to deploy the new MESAL™ Operational Excellence module in the reduction sector. This new enhancement of MESAL™ version 4.0 enables a complete follow-up of the quality of the operation made on the pots. Precise identification of any "on the field operation" that does not completely follow the standard operating procedures is then made. Upon deployment of corrective plans, anticipated progress is checked by the module.

Other installed functionalities such as Pot Tending Assembly (PTA) follow-up and PTA transfer management lead to a full view of the operations in potline areas.

## MESAL™ for Alumina

As a result of a major initiative conducted in 2014 with the active involvement of Rio Tinto Alcan Bauxite and Alumina R&D and Technology teams, the MESAL™ framework for alumina refineries is now available. This new framework is known as the "Manufacturing Excellence System for Alumina."

ONE MESAL™ now makes management of technical information related to operation and process possible for both refinery and smelter.

# 2015 begins with strong innovation initiatives on the AP Technology™ IT solutions

## Internet of Things : use case

Rio Tinto Alcan successfully achieved “proof of concept” (POC) to define a “use case” based on the innovative use of advanced collaboration tools, particularly mobile and related tools, for field players – operators – that provide a simple and natural connection to their control centre while they perform their usual activities in the field. Ultimately this functionality will be integrated within the Mobile MESAL™ extension.

The goal of this POC was to equip an operator with glasses and a tablet that are both connected to the plant network. While working in the shops, the operator is able to:

- Take HD photos and send them in real time to an application used by process engineers.
- Scan a text with the glasses or the tablet to gain access to the description of the equipment and identity as well as visualise KPI operation of the equipment or a process of intervention related to the equipment.
- Start an accurate and appropriate dialogue (audio and video) with a technician or process engineer to describe a situation, define a way to fix an issue or request additional information to validate a critical operation.

Another phase is now being studied to complement this first POC with other technology bricks including:

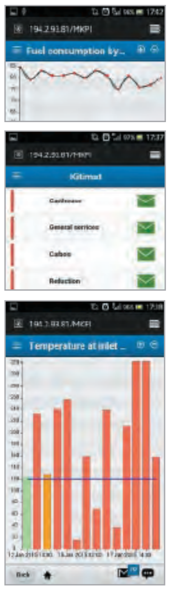
- Collaborative tools
- Mobility (smartphone, tablet)
- Real time
- Advanced processing data
- Cloud and big data

## MESAL™ mobility extension

Rio Tinto Alcan has designed a mobile app that enables remote access to KPI follow-up for a dedicated area or the full plant. This app is available for IOS and Android devices (smartphone and tablet) through local Wi-Fi infrastructure or via 3G/4G access.

This version will be deployed initially in Q2 2015 at the Kitimat smelter and will then be available from S2 2015 for all regions.

The design of this MESAL™ extension allows access to the KPI database of external systems such as ALPSYS or other applications (ERP, SCADA, Historian, other MES systems, etc.). Our goal is to offer a single point of access to a plant KPI repository to provide the plant management team with a global view of production and operations.


# AP60 and APXe

## A dual technology pot solution sharing one single platform

*AP60 pot*

The AP60 and APXe technologies use the same optimised framework (busbars, shell and superstructure) and operating equipment, while anode assemblies, cathodes and linings, ventilation and gas flow differ to suit the needs of each.

| **Feature** | **AP60** | **APXe** |
|---|---|---|
| Busbar | Common | |
| Shell | Common | |
| Superstructure | Common | |
| Alumina feeding device | Common | |
| Anode assembly | High productivity | Low energy |
| Cathode and lining | High productivity | Low energy |
| Shell ventilation | High productivity | Low energy |
| Gas flow | High productivity | Low energy |
| Pot control system (ALPSYS) | Common | |
| Equipment (pot tending assemblies, vehicles, ladles…) | Common | |
| Building | Common | |
| Operation | Common | |

While Jonquière's new AP60 smelter is proceeding with the validation steps for the AP60 technology under industrial conditions, the LRF is focussing on the full validation of the low energy consumption APXe pots. To reduce pot specific energy consumption, the APXe pot has a significantly lower electrical resistance and considerably reduced heat dissipated through the pot's external surfaces. The pot must be able to operate stably with a low ACD, very long anodes and limited bath volume.

Several versions of the APXe pot have been tested at LRF since 2011. The target is to achieve a potline SEC of 12.3DCkWh/kg, including all external voltage drops, which means that the pot energy consumption itself must be below 12.0DCkWh/kg. Following the start-up of the new Jonquière smelter, the last AP60 pots operating at the LRF had been stopped by the summer of 2014 and were restarted with the APXe pot design to validate operation in the range of 500-520kA at 11.8-12.0kWh/kg. The table below shows the initial results of the more recent optimised versions. These are very encouraging, with higher amperage, high current efficiency and reduced SEC.

| | Unit | Last 5 months 2014 |
|---|---|---|
| Amperage | kA | 507.0 |
| Current efficiency | % | 94.5 |
| Potline energy consumption | kWh/tAl | 12,240 |

By sharing the same platform as AP60, APXe automatically benefits from the industrial validation of the key components of the pot technology implemented at Jonquière, such as the busbars, the potshells, the pot superstructures (including gas collection), the alumina handling equipment, the pot process control system and main operating equipment such as pot tending assemblies, metal and anode transport vehicles. Full validation results from a combination of industrial validation of AP60 at Jonquière and validation of APXe specific items tested on the pots operating at the LRF.

| | AP60 | | APXe |
|---|---|---|---|
| Time to market | 1st generation (Jonquière 2014) | 2nd generation (2015) | 2015 |
| Current (kA) | 570 | 600 | 500 |
| Pot production (t/d) | 4.3 | > 4.5 | 3.7 |
| Specific potline energy consumption (MWh/t) | 13.3 | < 13.0 | 12.3 |

# AP30 Club

## A unique forum for AP30 users

*Club Members visiting Muscat*

The 11th AP30 Club meeting was held from 1 to 4 December in Muscat, Oman. This meeting, co-organised by AP Technology and Sohar Aluminium, was attended by representatives of all the AP30 plants now in operation across the world, totalling an annual production of 6 million tonnes.

This unique forum enabled AP30 users to share their technical experiences with their peers, review their HSE best practices and exchange on their specific process and operational constraints, as well as share successes.

The meeting in numbers: 15 AP30 smelters, 35 permanent guests at the technical session, 18 technical presentations and Q&A sessions.

The wide range of topics covered in the technical sessions illustrated the diversity of plant dynamics resulting from difficulties faced during unusual situations or challenges such as: power restrictions, anode dust or spikes, environmental issues, future and development plans, steep relining program, pot tending machine operating load, willingness to go fast in restarting pots, whole smelter start-up as well as improvement and change programmes.

The technical sessions held in Muscat and the tour of the Sohar Aluminium smelter in Sohar also gave AP30 Club members a glimpse of beautiful Oman.

The meeting provided a great opportunity for members to build their networks, share the challenges faced by respective smelters, identify areas for improvement and generate new ideas.

# The AP Technology™ smelter of the future

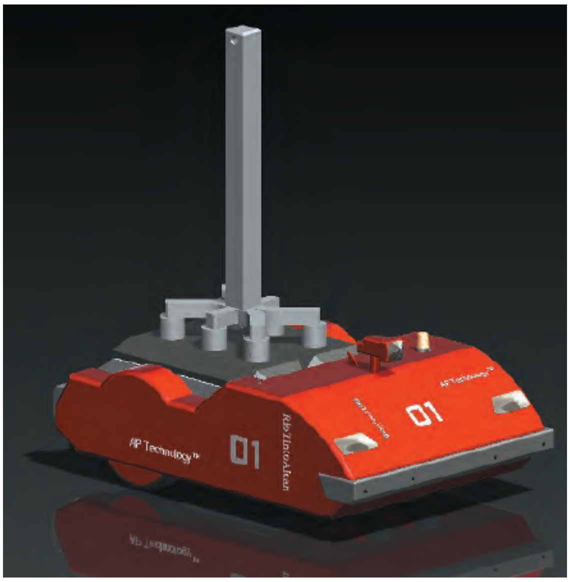
## New concepts and solutions for the smart smelter

*BAC*

The roadmap for the Smelter of the Future is built to integrate breakthrough technologies and solutions in AP Technology™ smelters as well as in other existing and future smelters, smoothly and continuously, creating value for all stakeholders.

As an example, ECL is developing the BAC (Fully Automated Anode Change) best in class anode change solution in a fully automated sequence as part of our Smelter of the Future approach. The BAC program consists of several bricks (tool positioning, hood handling, hammering sequence and ALPSYS/PTA interfacing), each of which can deliver value independently. The full automation also includes safety solutions for man-machine interference. Pilot tests in real industrial conditions started in 2014 at Jonquiere on the AP60 potline.

Another example is MAX™, our autonomous heavy load transport concept. This project targets the development of a single, lean, unmanned vehicle. The vehicle fleet will be fully integrated with Level 1 and Level 2 systems. It will improve flexibility, logistic fluidity and inventory management as well as mitigate risks associated with human driving. MAX™ will also contribute to the goals of zero emissions and low maintenance costs.




*MAX™*

# TMS 2015
## Walt Disney World, Orlando, Florida

At the TMS Light Metals Conference in Orlando from 16 to 19 March, Rio Tinto Alcan will present or sponsor nine presentations.

Our focus on **environmental issues** will be reflected in three presentations:

The first paper "Solution to Reduce Fluoride Emissions from Anode Butts" deals with an innovative and in-house solution of fully enclosing the butts in a bell after the anode change, dramatically reducing both fluoride roof emissions and operator exposure with a measured efficiency of nearly 100%.

Another very innovative approach will be presented with the paper "Use of the Life Cycle Assessment methodology to support sustainable aluminium production and technology developments". Life Cycle Assessment (LCA) methodology has emerged as a standardised reference for assessing the comprehensive environmental impact from any product or process, and is applied to all steps related to the product/process life, from cradle to grave. As a smelting technology supplier, Rio Tinto Alcan is now deploying a simplified approach based on LCA principles. The paper illustrates how this philosophy can be used to design and operate sustainable smelter technology solutions in a systematic way.

The third paper will be presented by Five Solios Inc. and is coauthored by Rio Tinto Alcan: it overviews Fives' most advanced and eco-designed scrubbing technology built around the Ozeos scrubbing modules with integrated reactors in the context of the start-up and early operation of Arvida Aluminum Smelter, AP60 Technological Centre.

In the **carbon domain**, a paper will be presented to demonstrate our commitment to improve anode quality in the context of degrading coke quality. We have developed a coke separation process based on coke density to maintain and even improve anode quality. High density particles are used in coarse fractions, whereas low density particles are crushed and used as fines. Use of the coke separator has resulted in an increase of the baked anode density by 0.015g/cm³. Results from the first six years of operation are presented.

In the **analytical technology** domain, three papers will be presented:

- Rotary flux injector: (RFI) – Recent development towards an autonomous technology
- Production and certification of metallic certified reference materials for the analysis of aluminium alloys
- Improvements in LiMCA technology: Introducing the LiMCA III

And finally, in the **reduction area**, we will present two papers:

- The first paper is about the start-up of the 38 cells of the Arvida Aluminum Smelter, AP60 Technological Centre at the end of 2013. This successful start-up has established a new benchmark for the primary metal aluminum industry in terms of productivity, robustness, environmental performance and CAPEX/OPEX benefits.
- The second paper presents the 3D modelling developments coupled with MHD and thermo-electrical modelling achieved at our R&D centres (LRF in France and ARDC in Quebec), applied to the AP40 and AP60 pots. These developments improve the pots' robustness and performances as recently demonstrated at the Arvida AP60 smelter.

These two presentations in the reduction area are built upon communications made in recent months:

At the **Australasian conference in November 2014**, we presented for the first time the successful start-up of the new Arvida smelter using the first generation of AP60 pots. The APXe low energy cell, the low energy version of AP60 operating successfully at the LRF (using the same basic design of busbars, shell, superstructure and operating equipment), was also presented, with the challenge to reduce dramatically the electrical resistance of the cell by increasing the electrical conductivity of various components, while simultaneously lowering heat loss by reducing the thermal conductivity of certain materials.

We used high performance measurement and modelling tools to successfully develop a reliable and high performance low energy cell. The pots at the LRF in France are operated at low anode-to-cathode distance with a low volume of bath, and at low pot gas suction while maintaining a high level of environment performance. The APXe cells are now operating in the range of 500 to 520kA with energy consumption as low as 12.3kWh/kg. The object of the next stage of development of these high amperage and low energy consumption cells is to achieve 11.7kWh/kg by 2016.

We also presented an **article at the JOM (Feb. 2015)** about the historical development of the AP Technology™ pot series starting with the AP13 in the 1960s. This development was historically based on a three stage pattern, the first one being the pot modelling, followed by the pot prototype stage and then the industrial stage which fully validated the technology. This development pattern has proven to be successful since it has led to the very robust AP Technology™ pot design generations. AP60 is the latest in this series. The development of APXe, which is the low energy version of AP60 operating successfully at the LRF and is also presented in the paper. In addition to this historical pot technology pathway, AP Technology™ also addressed the need for continuous and fast improvement of pot performances adapted to each existing client or site. To meet this need, a new development methodology recently emerged thanks to very high modelling capabilities. This methodology, based on the validation of "technology bricks", is presented in the last section of this article.

Learning from the past, dedicated to innovation and looking decidedly to the future, that is the mindset of the AP Technology™ team!

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At Rio Tinto Alcan, we are committed to ramping up smelter productivity and driving down energy consumption. From AP40 to AP60 for unprecedented productivity and from AP50 to APXe for dramatically lower energy use, our AP Technology™ platforms continue to break new ground.

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