INTERNATIONAL COMMITTEE FOR STUDY OF BAUXITE, ALUMINA AND ALUMINIUM
ICSOBA
NEWSLETTER

A biannual publication

Volume 12 – December 2014

CONTENTS

The picture on the front page shows a magician's performance at the Conference Dinner at ICSOBA-2014 in Zhengzhou, China.

In case you consider publishing in this forum, please contact the editor before writing your article.

Deadlines for a June issue is 10th of June and for a December issue 10th of December.

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Corporations Canada, Ontario under number 802906-7, and
Registraire des entreprises, Quebec under number 1167982181.

FOREWORD

Dear ICSOBA Members!

Last year, during the 31st ICSOBA conference in Krasnoyarsk (Russia) we all celebrated the 50th anniversary of our organization. The 32nd conference took place in Zhengzhou, China this past October and it marked the beginning of the second half-century for ICSOBA. The Zhengzhou conference was again a special one. It was well organized, thanks to the help of our Chinese friends, and welcomed first-class participants. Approximately 250 people took part in this event, more than half of these were from China.

Congratulations to all organizers for your effort and for your exemplary contributions. Spurred by a success last year, we staged another workshop with Dr Marc Dupuis. The subject this time was electrolysis.

I want to acknowledge the speakers, for their effort to prepare and present papers, and all session chairmen for their work. I want to thank all exhibitors for coming and displaying their products. I finally want to express gratitude to all our sponsors for supporting this conference. Without you, a non-for-profit organization like ICSOBA could not continue its mission. Thank you to our host sponsor, CHALCO; our gold sponsors, North East University Institute, Jingjin Filter Press, Hatch, Outotec, and Nalco; and our silver sponsors, Bruker, Cytec, ECL, Feluwa, Geho Weir, Sunresin, Newtime Valve, and Quanshun Flow Control. We are also grateful to the special sponsors, supporters and media partners. Thank you all.

The 2015 ICSOBA conference will take place in Dubai (United Arab Emirates) at the Rotana Al Murooy hotel from November 29th to December 1st. The event will be organized in cooperation with Emirates Global Aluminium (EGA). The jointly held, equal-ownership company integrates the business of Dubai Aluminium (DUBAL) and Emirates Aluminium (EMAL). Preparations for the 2015 conference are quite advanced. The 2016 conference will be in Quebec (Canada).

ICSOBA has never been to the Middle East. Our objective is therefore to offer our followers an opportunity to come to the Middle East and meet local colleagues. The 2015 ICSOBA conference will build on our historical strengths. The conference will allow international and Middle East specialists to share their professional experience and learn from one another. Additionally, international and local suppliers and manufacturers will be able to promote their products to new customers. Finally, the 2015 ICSOBA will recognize accomplishments of the Middle East region in its long term contributions to the global aluminum industry. ICSOBA has great privilege to invite you all to Dubai.

It was such an honour for me to be part of a strong ICSOBA tradition. Ten extraordinary men before me have held the responsibility of ICSOBA´s presidency, so I am very proud to have my name up with them. I thank you so much for giving me this unique chance and to have this opportunity to work for you and with you. In Zhengzhou, I stepped down as President to facilitate a transition (see ICSOBA Matters) but I remain on the Board of Directors.

There is no doubt that the period of time to come will be rich in accomplishments and equally rewarding for our organization. We look with optimism into the future. ICSOBA will continue its vocation as the world-class forum for the exchange of technical know-how. The ability to network with a wide variety of professionals from the global bauxite, alumina, and aluminium community is priceless. I thank you all for your contributions to our society during the year and I wish you success and growth in the year to come.

As the New Year approaches, ICSOBA´s Board of Directors wishes you and your family warmth and happiness and health over the holiday season and into the New Year.

Dr Frank Feret
Past-president, Vice-president, CEO

NEWS AND EVENTS

The 32nd International Conference and Exhibition of ICSOBA

The 32nd International Conference and Exhibition of ICSOBA entitled „New Challenges of Bauxite Alumina & Aluminium Industry and Focus on China" was held from 12th to 15th October 2014 at the Zhengzhou Research Institute of CHALCO, in Zhengzhou, Henan Province, China. The successful event was organized in co-operation with the host sponsor CHINALCO.

The number of participants was 275 including 142 foreigners and 133 delegates of Chinese companies. Out of 110 companies that were represented at the conference, 63 were foreign companies and 47 represented Chinese firms or universities.

The Conference consisted of two days of lectures following a Workshop on the aluminium electrolysis. On the opening day there were seven **plenary lectures** on various focal points of the Chinese aluminium industry and other selected subjects, such as technological developments in Emirates Global Aluminium (EGA), in Votorantim Metais and RUSAL Aughinish Refinery.

The **Bauxite and Bauxite Residue** session consisted of 12 presentations, the majority on various aspects of bauxite residue. 19 lectures were presented in the **Alumina Technology** session. The **Aluminium Production and Carbon Materials** session covered 20 presentations. A **Joint Technical Session** was also held covering among others improvement of the operational performance and the building application potential of fly ash. The conference proceedings (Travaux) were made available on pendrives and certain number of hard copies was produced as well.
Field trips were organized to visit the Zhongzhou Alumina Refinery of Chalco and the Jiaozou Wanfang Aluminium Smelter on 15th October.

Invitations were presented to the next ICSOBA Conference to be held from 29 November to 1 December 2015 in Dubai and to the Bauxite Residue Valorisation and Best Practices Conference, 5-7 October 2015 in Leuven, Belgium. In the evening of 13th October, a high level cultural programme, which included musicians, magicians and other artists was provided by the host sponsor.

The annual meeting of members, as well as the council meeting were held. Dr Jeannette See and Ms Marja Brouwer resigned from their posts of Directors of ICSOBA. Dr Frank Feret stepped down from the role of President of ICSOBA, though he remains on the Board. In order to increase visibility of ICSOBA a post of Honorary President was created. Dr Ali Al Zarouni of EGA, the host of the next conference in Dubai, became the Honorary President for 2015.

Some pictures from the 33rd ICSOBA Conference

Part of Presidency at the Plenary Session

Technical discussion at the Exhibitors' booths

Dr Marc Dupuis (workshop leader) and DrJianhong Yang

Dr Ali Al Zarouni of EGA –honorary president of ICSOBA in 2015

Technical Workshop on electrolysis

One of the meals

Plant visit at Zhongzhou Alumina Refinery

Plant visit at the Jiaozou Wanfang Aluminium Smelter

Flyer on the 33rd ICSOBA Conference

CALL FOR PAPERS
33rd CONFERENCE AND EXHIBITION

ICSOBA-2015

Organized by:
ICSOBA

In cooperation with:
EGA
dubal emal

Global and Gulf Region Developments in Bauxite, Alumina & Aluminium Production

29 Nov -1 Dec 2015
Dubai, UAE

INVITATION

Dear Colleagues,

The International Committee for Study of Bauxite, Alumina & Aluminium (ICSOBA) has great honor to announce the 33rd International Conference and Exhibition of ICSOBA. The event will be held at the Rotana Al Murooj hotel in Dubai from 29 November to 1 December 2015 in cooperation with Emirates Global Aluminium (EGA), the jointly-held, equal-ownership company integrating the businesses of Dubai Aluminium (DUBAL) and Emirates Aluminium (EMAL).

Objectives of the Conference are:

to review the status of bauxite, alumina and aluminium industries in the world with emphasis on the Gulf region;
to discuss promising research developments aimed at production, productivity and cost improvements;
to highlight proposed Greenfield and Brownfield activities in the aluminium industry;
to discuss developments in the field of recycling. environment and safety;
to update market aspects of bauxite, alumina and aluminium and their products;
to provide an excellent opportunity to interact with international experts, scientists, engineers, technology suppliers, equipment manufacturers and representatives of global aluminium industries.
We look forward to meeting you end of November 2015 at the ICSOBA-2015 in Dubai.

Dr Ali Al Zarouni, *Senior Vice President, EGA, and Honorary President of ICSOBA*
Dr Frank Feret, *CEO, V-President, ICSOBA*

CALL FOR PAPERS

The organizing Committee is inviting the submission of papers. Please contact us before writing your abstract. Enquiries and abstracts can be sent to icsoba@icsoba.info. Abstracts should include the title, the text not exceeding 200 words, and the author's name(s), affiliation, position and email address of the corresponding author.

Deadlines for abstracts and final manuscript sending

Final Abstract:	15 June 2015
Full Paper:	15 September 2015
Presentation and bio data:	15 October 2015

Abstract, final manuscript and presentation are to be submitted according to the *Author guidelines & template* that can be downloaded from ICSOBA's website.

REGISTRATION & FEE

As of March 2015 info and registration form can be found at http://www.icsoba.info/icsoba-2015. Or you can send an email to icsoba@icsoba.info for receipt of registration form and payment information. After registration you will receive an invoice for paying by credit card or wire transfer.

Fee in Canadian dollars (CAD)	Normal	Payment before July
Conference listener	900	750
Conference speaker	800	700
Student	350	250
Accompanying person	250	200
Optional plant visit	180	180

ICSOBA has blocked a limited number of rooms at the venue and two other nearby Rotana hotels. Delegates can make reservation for these rooms at a reduced rate together with their registration. For details on hotel reservation please see ICSOBA website.

ICSOBA

The International Committee for Study of Bauxite, Alumina and Aluminium, ICSOBA, was formed in 1963 in Zagreb (Yugoslavia), and has become a truly international and independent organization. The main objective of ICSOBA is to promote the exchange of ideas and results of work from different fields of research and practice related to bauxite exploration & mining, and alumina and aluminium production.

Since 1963 ICSOBA has organized 30 International Events in Europe (Greece, France, Hungary, Russia, Germany, etc), Asia (Iran, India, China), the Americas (Canada, Brazil, Jamaica) bringing together aluminium producers, researchers, technology suppliers and service companies.

ORGANIZING COMMITTEE

General coordination: Ali Al Zarouni - EGA
Michel Reverdy - EGA
Speaker program: Xiangqing Chen (Chalco), Roberto Seno (Votorantim) - bauxite
Steve Healy (RTA) - alumina
Vinko Potocnik (EGA) and V. Buzunov (Rusal) - electrolysis
Matthieu Arlettaz (R&D Carbon) - carbon

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CONTACT US

ICSOBA executive office

For questions on registration, payment, speaker program, exhibition, sponsor opportunities, for sending abstracts, papers and presentations, for requesting Author guidelines & template please contact:

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GULF REGION DEVELOPMENTS

Primary aluminium capacity in the Gulf region is more than 5 mln tonnes in 2015 representing approximately 10% of the world primary metal production.

Emirates Global Aluminium (EGA) owns 2 smelters in UAE (Jebel Ali Operations – Dubal and Al Taweelah Operations – EMAL) with a total capacity of 2400 ktpa. Aluminium Bahrain (ALBA) operates a smelter in Bahrein with a capacity of 915 ktpa and projects to build a sixth potline with a capacity of 500 ktpa. First metal is planned for early 2018. Qatalum operates a smelter of 635 ktpa in Qatar. Sohar Aluminium operates a smelter of 370 ktpa in Oman. Ma'aden operates a smelter of 740 ktpa in Saudi Arabia.

EGA projects to build a 4 mln tonnes alumina refinery in Al Taweelah (UAE). Production should start towards the end of 2017.

Technical field trips on November 29

The ICSOBA-2015 program provides for visiting:

DUBAL smelter (Dubai)

Commissioned end-1979. After sequential expansions, advancing technologies, the smelter has 1,573 reduction cells in seven potlines (>1 M tpa), Casting operations (>1 M tpa). 2,350 MW power station, 30 million gallon/day desalination plant and Port facilities.

EMAL Smelter (Abu Dhabi)

Commissioned end-2010 (phase I) and mid-2014 (phase II). The smelter has 1,200 reduction cells in three potlines (>1.35 M tpa), Casting operations (~1.6 M tpa), 3,100 MW power station, 3.75 million gallon/day desalination plant and Port facilities

PROGRAM

Speaker program on 30 November and 1 December

- Bauxite and bauxite resources
- Alumina production and residue solutions
- Primary aluminium production
- Carbon and carbon materials
- Aluminium products and alloys

Exhibition

During the Conference there will be an Exhibition of latest technologies, equipment and other devices for the aluminium industry. Companies can give a presentation at the Exhibition.

Welcome drinks - Meet and Eat

On the evening of Sunday 29 November the Conference will kick-off with welcome drinks & snacks following registrations at the welcome desk.
In the tradition of ICSOBA all lunches & dinners during the speaker program are included in the program in order for you to have maximum opportunity to meet other delegates, at no additional charge.

Papers and presentations

Language for papers and presentations is English.
Papers will be published in ICSOBA proceedings.
Authors have the option to have their papers published by China Academic Journals Electronic Publishing House against a Network Database Retrieval Card.
Delegates receive all papers and presentations as pdf on CD or memory stick.

Invitation to the Bauxite Residue Valorisation and Best Practices Conference

BAUXITE RESIDUE VALORISATION AND BEST PRACTICES CONFERENCE

Leuven 5-7 October 2015

We are very happy to announce the Bauxite Residue Valorisation and Best Practices conference that will take place in Leuven, on 5-7 October 2015.
The conference aspires to cover the whole chain of bauxite residue from production to applications and demonstrate that bauxite residue is a resource.

Conference topics

The following topics will be covered:

- From bauxite to a modified bauxite residue
- Neutralisation, re-vegetation and beyond
- Recovery of major (Fe, Al, Ti), minor and rare earth elements
- Cement, concrete, ceramics and inorganic polymers
- Other novel applications

Scientific Programme

- Each session will be opened by keynote lectures given by specialists and high level representatives from both academia and industry.
- Oral presentations will follow where participants will present their work. Poster presentations will also have the option to present the main findings orally.
- The conference will close with an open discussion on the important findings, messages-to-take-home and further actions.
- The revenues from the conference will become an award, compensating travelling, accommodation and working costs for a researcher to come and spend time in KU Leuven, giving access to top-notch facilities

5-7 OCTOBER 2015

http://conference2015.redmud.org/

Save the date

- Abstract submission deadline: **28th February 2015**
- Notification of acceptance: **1st April 2015**
- Full paper submission deadline: **30th June 2015**
- Final program: **1st September 2015**

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TECHNICAL PAPERS

A Review of the Technological Developments of the Aluminium Electrolysis

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Abstract

Over 100 years ago, the discovery by Hall and Heroult enabled the production of aluminium on an industrial scale, a technology that has not been superseded since. In February 2011, celebrating the 125th anniversary of the Hall-Heroult process provided an opportunity not only to pay tribute to the inventors, but also to review the key developments in the field. The Hall-Herault process now produces over 50 million tons of aluminium annually in about 200 smelters in 43 countries [1].

Although the underlying chemical processes have remained basically unchanged over time, the operating technology has improved significantly. The paper surveys the evolution of these operational and technical improvements, looking at primarily the Söderberg and prebaked anode cell constructions. The underlying scientific aspects as well the current research and development efforts are also addressed.

The paper then provides an overview of the recent changes in the global aluminium industry. It analyzes the challenges faced by Western European and North American smelters and discusses the increasing presence of producers from emerging markets.

Keywords: aluminium smelting technology, improvements of prebaked and Söderberg technology

1. Initial Developments

Hall and Heroult, while independently developing substantially similar production technologies, laid the foundation for two different directions of the aluminium production:

- given the availability of cheap electricity in the US, the method proposed by Hall resulted in profits being proportional to the amount of metal produced. This resulted in higher anode current density, larger heat losses and energy consumption as well as shorter cell life.
- the process used by Heroult in Europe, the primary impact on profits came from the reduction of production costs. Consequently, this process is characterized by lower anode current density, lower daily cell production with longer cathode life as well as lower energy consumption and higher investment costs.

The initial development of electrolysis cells proceeded in a similar fashion using the two distinct processes. The first prebaked cells were put in operation mostly in North America and Europe. In this early period, manual labor was essential in operations and so this expertise was highly valued. As such, labor was also a significant part of total production costs. In the early period, data were not being captured and analyzed to support operational processes: metal data was only analyzed every second day, molar ratios, the frequency and magnitude of the anode effects were only reviewed weekly. Determination of cell voltage based on very limited data points was therefore highly subjective and prone to errors.

The applied line current is the principal factor impacting the efficiency of the aluminium electrolysis process and the related investment costs. Thus, the increase of current as well as the reduction in energy consumption became key operational and technical objectives.

The increase of line current, however, is limited by the electromagnetic forces generated in the molten metal. These forces distort the metal-electrolyte interface and increase the rate of aluminium dissolution in the electrolyte, which in turn causes reduced current efficiency. The decrease in current efficiency can therefore only be compensated by a larger anode-cathode distance, which involves higher energy consumption.

2. Review of the Söderberg technology

a. Söderberg technology over the years

The first main breakthrough was achieved following the 1918 patent by Swedish-born Carl Wilhelm Söderberg. Based on the principle of the self-baking anode, the anode mass (coke and tar 25-30%) is added onto the top of the anode in the cell. This then ensures that the baking process takes place within the cell and therefore that is where the carbon anode develops.

This technology reduces investment costs and generates savings of 400kWh/t Al due to the lower production and investment costs of anodes.

The first Söderberg cells were built in 1923 in Europe. The technology was then quickly adopted throughout Europe. In North America, the Söderberg process was used primarily in Canada. By the early 1950s, aluminium produced using this technology accounted for half of the world's total primary aluminium production output.

During the 1950s, the most significant developments around the Söderberg technology were initiated and driven by Pechiney (France). They successfully installed this technology in their Saint Jean de Maurienne pilot plant. Based on the encouraging experimental results, 100 kA vertical Söderberg cells were also installed in the Auzat smelter.

It was established that the magnetic forces would not be allowed to increase the line current above the 100 kA range, since given that at this line current, efficiency would decrease and energy consumption increase. For this very reason – based on observations – the busbar design was modified. The anode positions in end-to-end cell layouts were to be controlled.

The crust breaking/alumina feeding was also changed to scheduled anode effect and crust breaking/alumina feeding procedure. In addition, the molar ratio of the electrolyte was also reduced. Through the automation of the auxiliary processes and a general improvement in machinery and equipment, the labor component of the electrolysis process was reduced to 4.5 hours/t Al value.

Table 1 below summarizes the parameters based upon the best energy consumption results, which were obtained in Pechiney's Noguères smelter.

Table 1: Söderberg reference plant results

Parameters	Value
Anode size	2.1 m x 6.5 m
Anode current density	0.72 A/cm^2
Energy consumption	From 14,800 to 15,000 kWh/t Al
Current efficiency	88%
Anode consumption	520 kg/t Al
Fluoride consumption	37 kg AlF_3/t Al
Direct labor	4.5 hours/t Al

Primarily due to the success of the Noguères reference plant, several countries, such as Spain, Poland, Brazil and Japan, chose to adapt these new technologies and established similar smelters. Using modified Noguères technology, Mitsubishi Light Metal Company's Naoetsu smelter reached excellent results in the 110-120 kA current range. Energy consumption fell to 13,500 kWh/t Al, anode consumption was 500kg/t Al at a current efficiency of 89-92 % [2]. Nevertheless, even these achievements could not ensure the competitiveness of Japanese aluminium production and these smelters were then gradually shut down during the 1980s due to the sharply increasing energy prices [3].

The large-sized anodes led to longer gas routes, which in turn resulted in more turbulence in the electrolyte. In addition, these anodes could not sufficiently compensate the effects of the increased magnetic current. As the aforementioned limitations could only be compensated via higher anode-cathode distance, which then resulted in higher energy consumption, the modified Söderberg technology did not meet the initial expectations. These constraints have led to most Western European smelters abandoning any further research and development efforts on this technology.

With the increasing energy prices starting in the 1970s, the economic pressure on Söderberg smelters increased significantly. In addition, social pressure to address environmental concerns also increased.

The main technological problem was benzo(a)pyrene released into the atmosphere by the anode mass from the binding material (coal tar pitch). Using the so-called “dry anode mass” in production, developed by Sumitomo, the concentration of benzo(a)pyrene could be reduced in the atmosphere of the potroom. This technology has been applied in numerous smelters worldwide.

In order to reduce the concentration of dust in the potroom, sandy alumina is used instead of the previously used floury alumina and the knife-type crust breaking was introduced instead of the hammer-type crust breaking. This method of crust breaking uses pressure to break the crust and feed the alumina into the electrolyte. In addition, the number and the duration of the anode effects were also significantly reduced, lowering the overall energy consumption and the environmental concerns.

Fig.1 Dry anode mass on the anode top

Nevertheless, these improvements did not secure the operational superiority of the Söderberg technology. When market conditions turned unfavorable (metal prices decreased), operations using this technology were among the first to be temporarily halted or even permanently shut down. In countries with relatively cheap electricity, such as Norway, Russia and Canada, significant efforts were undertaken to maintain output levels and additional R&D efforts were carried out to improve and optimize the technology.

On the other hand, Söderberg technology continued to be widely used in the former Soviet Union during the 1980s. Previously, the Soviet Union exclusively relied on its domestic production technology. The VAMI Research and Development Center, affiliated with the Irkutsk smelter, developed a robust 100 kA Söderberg vertical stud construction. This technology was then exported for the construction of the Bharat Aluminium smelter in India, the Nag Hammadi smelter in Egypt, the Puksan smelter in North Korea and the Seydisehir smelter in Turkey.

Söderberg vertical stud cells were built at higher than 100 kA current intensity (150 kA range), in countries where the more expensive technology could have been compensated with lower electricity prices.

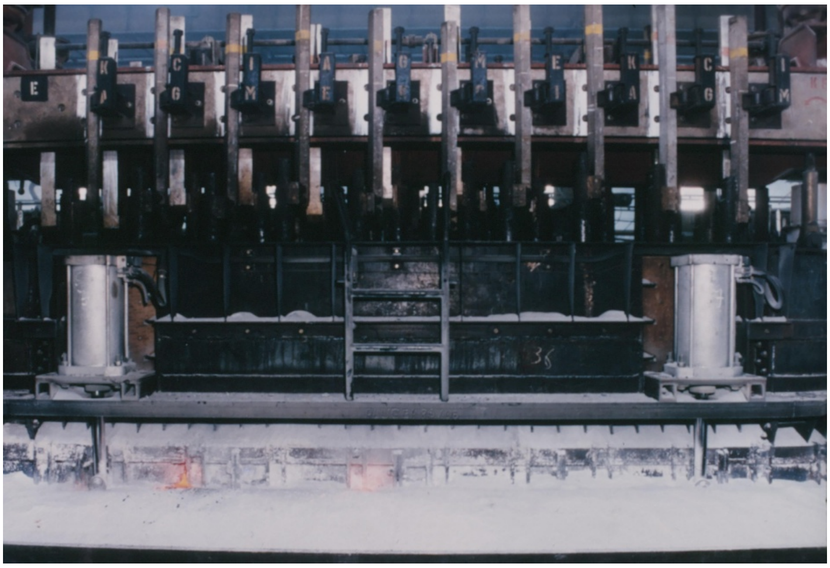

Fig. 2 Knife-type crust breaking in Sumitomo technology

b. Recent trends and future outlook

Table 2 below shows the largest smelters operating on the Söderberg technology.

Table 2: Largest Söderberg aluminium producers

Country	Smelter
Russia	Bratsk and Krasnoyarsk (RUSAL)
Norway	Mosjøen and Lista (ALCOA-Elkem)
Norway	Karmøy (Hydro Aluminium)
Canada	Kitimat (Rio Tinto Alcan)

As Table 2 clearly indicates, Norway and Russia led the development of the Söderberg technology. The Norwegian operations are characterized by point feeding of alumina and the feeding into the electrolyte under skirt, covering the entire anode surface and the cleaning of gases exhausted from the anode top. Even though this technology has been operating well in the Elkem smelter, it has not been extended to other sites [4].

In Russia, the RUSAL Krasnoyarsk smelter developed an environmentally friendly technology, which improved the efficiency of gas collection by modifying the gas skirts, introduced the dry gas cleaning technology and used point feeding to control alumina content in the electrolyte. In addition, a new composition of anode mass "colloidal anode" was developed and new control algorithms in cell automation were introduced [5].

Key parameters of the Norwegian and Russian Söderberg technologies are presented in Table 3. Table 3 shows that fluoride emissions and environmental standards for benzo(a)pyrene content have been met in both countries, but energy consumption remained relatively high. Therefore, these technologies can be used only at relatively cheap electricity prices.

Despite the significant progress in operational and technological aspects, the survival of the Söderberg technology remains increasingly in doubt due to the increasing energy prices. As an example, even at the low electricity prices in Norway, Hydro Aluminium was forced to close its 120 kt/year capacity Karmøy (Norway) smelter.

In many smelters, the Söderberg technology has been gradually replaced by the prebake anode technology. Pechiney and VAW (Germany) played a leading role in this technology transfer. Rusal, one of the largest global producers using the Söderberg technology, has developed its proprietary pre-baked anode technology and will be shutting down the old Söderberg cells still in operation. Its Krasnoyarsk smelter was originally built in 1964 [7], but has been gradually refurbished and modernized since.

Table 3: Comparison of key parameters in Russian and Norwegian smelters
Ospar: Oslo-Paris agreement on emissions of aluminium electrolysis [6].

Parameters	*Ospar specifications #*	Krasnoyarsk (Russia)	Mosjøen and Lista (Norway)
Current, kA		174	123
Current efficiency,%		91.5	91.5
Cell production, kg/day		1,320	850
Energy consumption, kWh/t Al		15,500	16,900
Anode consumption, kg/t Al		490	495
AlF_3 consumption, kg/t Al		15-17	15
Fluoride emission, kg/t Al	≤ 0.6	0.6	0.5
Benzo (a) pyrene, kg/t Al	≤ 0.01	0.0085	0.0080

Rio Tinto Alcan has also been upgrading one of its high-capacity smelters to prebaked anode technology. Pechiney installed the prebake anode technology in its Edea smelter in Cameroon, where a 20kA current increase and a reduction of 2,500 kWh/t Al energy consumption were achieved. It is to be noted that this upgraded technology requires the complete redesign of the busbar system.

These modifications in the busbar design and operation have not been an extended success. The increase in output did not cover the higher investment costs, which rose to US$ 2700-3200/ton Al. The transition to the prebake anode technology resulted in a current increase of 25kA, energy savings of 2800 kWh/t Al, and a labor reduction by 3 hours/t Al. As a result, most producers decided to shut down old smelters and go for “green field” smelter construction instead.

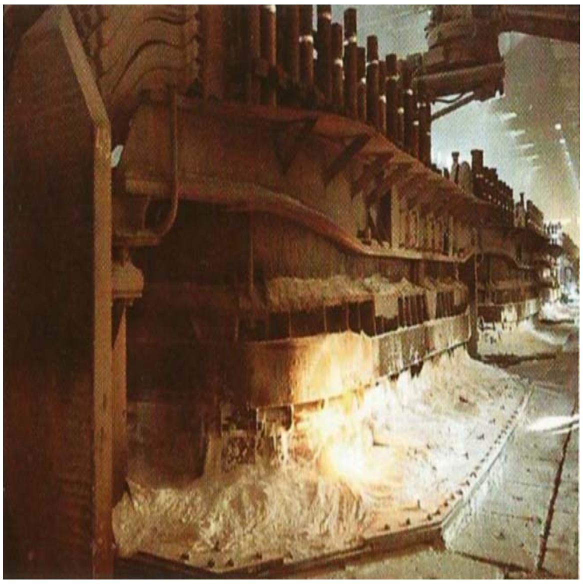

Fig.3 Söderberg cells before reconstruction

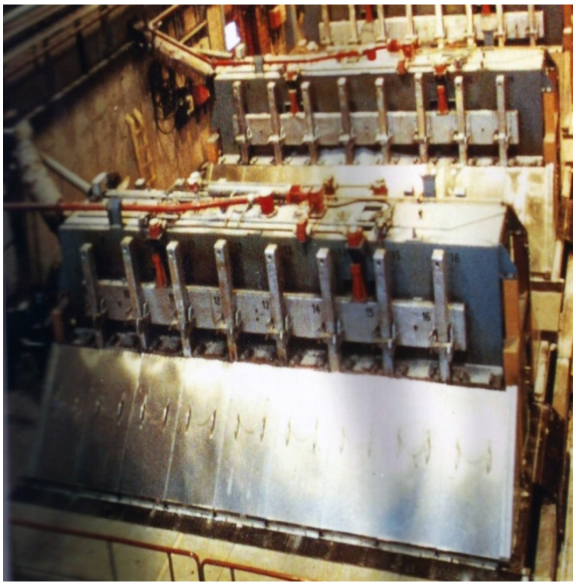

Fig.4 Prebaked anode after reconstruction

With the exception of China, the Söderberg technology, including horizontal Söderberg studs constructions, now accounts for less than 10% of the world aluminium production. This represents a sharp drop since the 1970s, where 40-50% of the total primary aluminium was produced using the Söderberg technology.

3. Prebaked anode technology

The year 1962 was a real milestone in the development of electrolysis technology. The leading aluminium producers convened in New York, where delegates of the Soviet Union and Hungary were also invited. Significant new research results were presented during the conference that laid the groundwork for the future development and refinement of electrolysis technologies. The participants agreed that 100 to 125 kA current represents the upper limit of the Söderberg technology and additional increase in current would lead to a decrease in current efficiency and higher energy consumption.

The research conducted by Givry [8] provided the theoretical background for the further increases in line current. He found that the vertical component of the magnetic field strength and the horizontal currents in the molten metal create a dynamic force effect, which causes distortion and results in higher movement velocity. This, in turn, increases the rate of the re-oxidation process and reduces current efficiency. Givry derived the equations by which the optimal busbar arrangement, having the minimum impact strength, can be calculated. To do so, one first has to calculate the components of the magnetic induction applying the Biot-Savart law and the current density component vectors. These so-called Laplace forces can be obtained by the vector multiplications of the magnetic induction and the current density components. Then the distortion of the metal and velocity vectors using the Navier-Stokes equations can be calculated. In the early 1970s, the necessary computing tools were not available to carry out these calculations, even though the theoretical basis had already been known.

The research showed that only the prebake anode technology allowed for an increase in line current and lower energy consumption. It was also recognized that in order to better utilize the production area, the prebaked anode cells should be placed transversally (side-by-side).

However, this decision was not driven by a deliberate application of magnetic compensation. The development of the prebaked anode technologies was given a strong push as Western European producers have gradually started moving away from the Söderberg technology. The research and development around prebaked anode technology primarily concentrated on construction technologies and immediate operational efficiencies.

The largest aluminium producers, such as ALCOA, Reynolds, Kaiser Aluminum developed and commercialized their own prebaked anode technologies. By the end of the 1960s and early 1970s, North American producers largely surpassed their Western European competitors. The North American technology was characterized by current in the 150-180 kA range, the transversal layout of cells in the potroom (side-by-side arrangement) and two-end risers busbar arrangement. The technology also operated with knife-type crust breaking or point feeding located between two rows of the prebaked anodes. Cells were covered and escaping gases were captured and collected with a wet or dry gas cleaning system.

Table 4 below summarizes important parameters of the North American prebaked anode technologies. It is to be noted that these cells were located in a side-by-side arrangement in the potroom and the busbar was laid out in a two-end or central-risers configuration [9].

During this period, the North American producers had the leading role in technology transfers. Kaiser's P-69 cell became the most popular technology outside North America.

At the same time, side-by-side cells with two-side risers busbar configuration were built in Western Europe. The main characteristics are shown in Table 5.

Even though North American producers achieved great success in technology transfers, the energy consumption and the current efficiency lagged behind the technologies of the Western European competitors.

Concurrently, in order to optimize busbar system and to develop better thermal models, the largest aluminium producers started using more robust computer models. Sophisticated modelling and production systems were deployed at ALCOA [10], ALCAN [11], Hydro Aluminium [12, 13], Kaiser Aluminum [14], Alusuisse [15], Pechiney [16] and VAW [17]. Using computer models, Pechiney was able to implement an optimized busbar arrangement and improve its thermal models [18]. In addition, using computer models, the equation systems set up by Givry [8] were solved, which resulted in technologic improvements to minimize the electromagnetic forces impacting the metal. This enabled the reduction of the anode-cathode distance, the improvement of the current efficiency and reduction of the energy consumption.

Table 4: Smelter operation with two-end risers construction using North American technology in the 1970's

Company	Type of Cell	Current	Busbar	Alumina feeding	Smelters
ALCOA	P-155	155-180 kA	central		Badin (US), Grande Baie (CA), Port Henry, Laterrière (CA), Sebree (US)
	A-697	180 kA	central	point feeding	Mt. Holly (US), New Madrid (US), Sao Luis (BR)
Kaiser	P-69	140-175 kA	end	center crust breaking or point feeding	Hollyhead (US), Dubai (AE), Tema (US), Hawesville (US), New Madrid (US), Tiwai Point (NZ), Voerde (DE)
	P-80	180-190 kA	central	point feeding	Chalmette (US), Tacoma (US)
Reynolds	P-19	145-165 kA	end	center crust breaking and point feeding	Hamburg (D), Puerto Ordaz (VE), Ikot Abasi (NG), Santa Cruz (BR)
	P-20	170 kA	central	point feeding	Ikot Abasi (NG)
	P-23	180 kA	central	point feeding	Ikot Abasi (NG)

Table 5: Smelter operations using "Western European technology" in the 1970s

Company	Type of Cell	Current	Busbar	Alumina Feeding	Smelters
Alusuisse	EPT-18	180-190 kA	central	point feeding	Rheinfelden (CH)
VAW	CA-180	180 kA	central	point feeding	Töging (DE), Grundartangi (IS)
Pechiney	AP-13	130 kA	end	central crust breaking	Belem (BR), Fernandel (US), Vlissingen (NL), Mostar (BIH), San Ciprian (ES), Frederick (US)

Fig 5. The Kaiser P-69 cell design

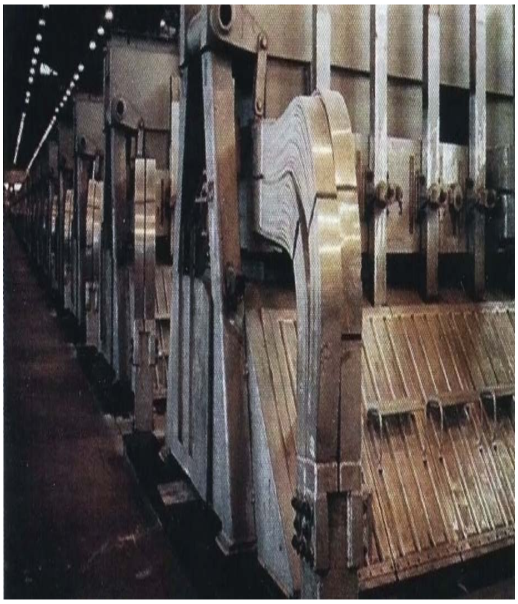

Fig 6. Hydro two-side risers construction

The development of Pechiney's 180 kA "four risers" solution further reduced the vertical component of the magnetic induction, which in turn led to a reduction of forces acting on the molten metals. Such a breakthrough in the electrolysis technology laid the groundwork for the current technology, characterized by high current efficiency.

Table 6: Parameters of Pechiney's 180 kA (AP18)"four risers" technology

Parameters	Value
Current	180 kA
Cell production	1,360 t/day
Current efficiency	94 ± 1%
Energy consumption	13,200 ± 200 kWh/t
Cell life	≥ 6 years

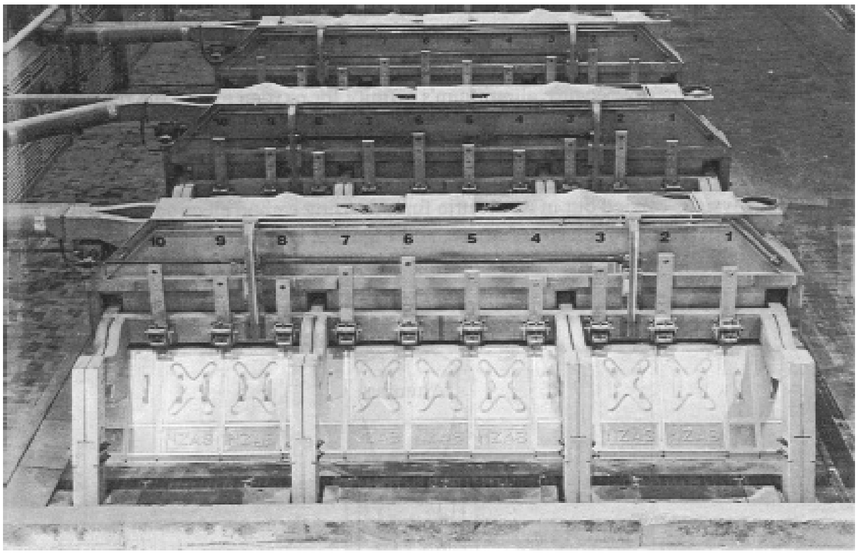

Fig. 7 The Pechiney AP-18 "four risers" cells

Due to the rapid progress of Pechiney's "four risers" design and the successful transfer of this technology, the company became the undisputed market leader in smelter technology. Thus, most of the other producers largely abandoned their own research and development efforts in this area.

The global distribution of the AP-18 "four risers" design and technology is highlighted in Table 7 below.

Table 7: Cells operating the Pechiney AP-18 technology

Smelter	Number of cells	Capacity (kt/year)
Saint Jean Maurienne (France)	60	29.8
Tomago (Australia)	780	387.2
Becancour (Canada)	720	357.4
Lochaber (Scotland)	80	39.7
Karmoy (Norway)	222	110.2
Angul (India)	480	238.2
Baie Comeau (Canada)	480	238.2
Kidricevo (Slovenia)	80	39.7
Puerto Madryn (Argentina)	272	140.0

In 1986, Alcoa, using its proprietary technology, built the 275-300 kA smelter in Portland, Australia. Hydro Aluminium also developed the four risers construction in the Høyanger smelter and built two additional plants in Venezuela and Slovakia.

From Pechiney's published research, it became apparent that they continued developing cells at higher amperages. In the second half of the 1980s the development and commercialization of 295 kA cells were carried out, which proved to be very successful world-wide in numerous operations.

At this current level, using 264 cells, a production capacity of 215 kt Al / year can be achieved.

Table 8 summarizes the parameters of this type AP-30 cell construction [19].

Table 8: Parameters of Pechiney's 295 kA "five-riser" technology

Parameters	Value
Current	295kA
Current efficiency	94-95%
Cell daily production	2,235 kg Al/day
Energy consumption	13,500kWh/t Al

Smelters built in the 1990s predominantly used this technology, ensuring Pechiney's global leading role in electrolysis technology [20]. Close to 2,100 cells were built using the AP-30 technology with a total capacity of around 2 million tons of Al/year. The AP 30 technology and construction were then further enhanced resulting in the AP-35 model with reported amperage of 350 kA [19]. The AP-30 and AP-35 constructs differed from the AP-18 technology in that they used a "five-risers" busbar system, graphite cathodes and five point feeders to deliver alumina. Each cell was equipped with probes to measure the height and temperature of the electrolyte. These measurements were subsequently analyzed using expert control systems. Using the AP-35 construction, a production capacity of 320 kt Al / year was achieved. ALCOA built 336 cells using this technology in the Fjardal smelter in Iceland and 360 cells in Sohar (Oman) [21].

Table 9: Global smelter capacity of the AP-30 construction

Smelter	Country	Company	Capacity (kt/year)
Dunkerque	France	Pechiney	215
Deschambault	Canada	Alumax	215
Alouette	Canada	Alouette	215
Puerto Ordaz	Venezuela	Alcasa	195
Alba	Bahrain	Alba	235
Mozal	Mozambique	Billiton	560
Alusaf	South Africa	Glencore	460

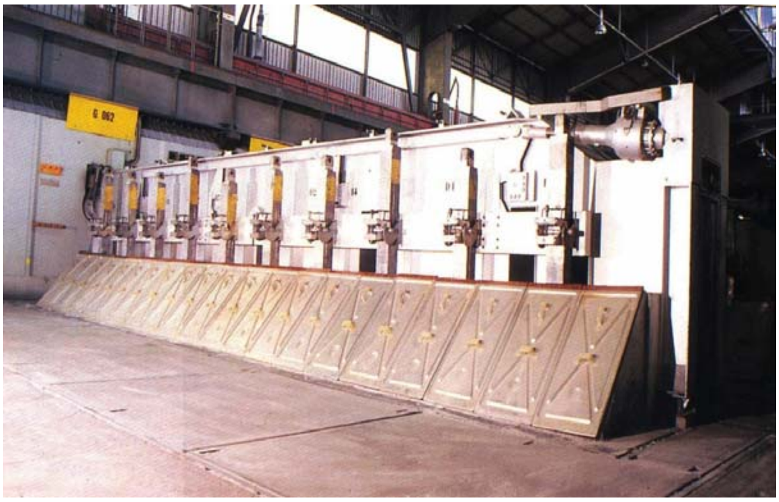

Fig. 8 AP-30 cell design

During the 2000s, Western Europe, primarily ALCAN Pechiney, was still the principal hub of the research and development and the most significant exporter of technology and know-how. The comparatively high energy prices in Western Europe necessitated continuous technological improvements so that operations could remain economically viable and globally competitive. At the same time, while adapting these technologies, North American producers gradually phased out their in-house research and development functions. Western European producers eventually lost their market leadership as some of the smelters were shut down or acquired by overseas competitors.

4. Operational improvements

Major operational improvements began in the 1960s with the implementation of point feeding of alumina in order to help reduce the use of labor. The initial trials were inconclusive because the feeding process was timed and the variance in current energy efficiencies between cells resulted in sludge formation or more frequent anode effects. Despite these initial setbacks, alumina feeding became a critical aspect of the operational technology. Almost all the main aluminium producers carried out proprietary research and development in this area.

Two critical factors promoted the development of the point feeding procedures. One was the ability to install point feeding equipment on each individual cell. The other was the use of digital technology based on Goodnow's results [22] that allowed the use of on-demand alumina feeding technology.

Initially, beam or knife-type crust breaking was installed in between the prebaked anode lines and the alumina was fed into the electrolytes through a hole from dedicated alumina tanks.

The alumina feeding process was later improved with point feeding. The feeding process is made up of the following two components:

- an under-feeding period, during which only 50-75% of the required alumina is fed in the electrolyte;
- as the resistance of the cell reaches a critical point indicating that anode effect will take place, 150-170% of the required alumina is fed in the electrolyte.

From an operational standpoint, the introduction of the point feeding process resulted in higher current efficiency, as the lower alumina concentration in the electrolyte prevented the formation of sludge on the cathode in the cell, which then reduced the formation of horizontal currents in the molten metal.

Fig. 9 Crust breaking and alumina feeding

Another major operational breakthrough was the introduction of cell process control systems. These systems were used to capture and track operational data and provide timely and relevant performance indicators for decision-making.

The operational control of the cells is based on the measurement of cell resistance. Given that there is significant "noise" with the measurement of cell voltage, analog measurement and control systems had limited success. The major breakthrough came with the introduction of digital technology.

By sampling cell resistance (serial current, voltage), filtering and analyzing the measured data, the following key objectives can be enabled:

- regulation of cell resistance;
- forecast and control of anode effect and alumina content in the cells;
- identification of anode movement and its extent;
- noise analysis to detect operational failures;
- observation and control of auxiliary processes such as prebaked anode changing, metal tapping, AlF_3 feeding, chemical analysis of metal impurity data, electrolyte tapping.

The most common process control systems in use are Celtrol (Kaiser), ELAS (VAW), ALPSYS (Rio Tinto Alcan) and HAL3000 (Hydro Aluminium). In addition to these existing control systems, expert systems and training systems have also been developed to help manage operations and to provide training for operators, respectively [23, 24].

5. The reshaping of the global aluminium industry

a. Western Europe

While in the 1990s, Western European countries produced 25-30% the world's aluminium production, this figure dropped to 4-5% by the mid-2000s. The accelerating process of globalization during the 2000s resulted in Western European producers gradually losing their dominant, market-leading positions [24]. Many producers had to sell assets or had to shut down smelters. A further effect of globalization was the significant changes in the ownership structure of the major producers in the whole Europe. In Western Europe, a portion of Germany's leading aluminium group VAW was sold to Hydro Aluminium, while the remaining capacity was acquired by the TRIMET. RUSAL acquired full ownership of the Swedish Sundswal and Ukrainian Zaporozhye smelters and partial ownership of the Podgorica smelter in Montenegro. RUSAL thrived in the globalized marketplace, not only by acquiring European assets, but also by purchasing the majority stake in the Abasi smelter in Nigeria.

Among the 28 countries in the EU (European Union), two smelters (Dunkerque and Žiar nad Hronom) are considered to be state of the art and meet the most stringent environmental standards. However, as environment standards become even stricter, even these two smelters face dim prospects. In Europe, only Iceland built a new smelter during the 2000s. Alcoa's Fjardaál smelter was based upon the proven Pechiney technology in place of its Deschambault smelter. The establishment of the facility was also driven by the long-term availability of cheap geothermal energy, which does not involve carbon-dioxide emission.

Overall, it is safe to conclude that by the end of first decade of the 21st century, aluminium production in the 28 EU countries virtually stopped.

Table 10: Western European smelters that were shut down during the 2000's

Country	Smelter	Capacity, kt/year
United Kingdom	Anglesey	135
	Lynemouth	175
	Fort Williams	42
Germany	Norf	220
Netherlands	Vlissingen	200
Spain	Aviles	88
	La Coruna	82
France	Lannemezan	50
Poland	Konin	53
Switzerland	Steg	44
Italy	Fusina	43
Hungary	Inota	34

b. North America

In North America, the market went through a period of consolidation, where large aluminium producers bought local competitors. Alcoa acquired Alumax, Reynolds and a number of other players. With rising energy prices and declining production in North America, some of the newly acquired smelters had to be closed. The uncompetitive operational and management practices at these entities further exacerbated this process.

Instead of pursuing greenfield investments, Alcoa decided further acquisitions to increase production capacity in other locations. After the acquisition of smelters in Spain and Italy, Alcoa increased its 50% stake in Norwegian smelters Mosjøen and Lista to full ownership. As negotiations for more favorable energy prices proved to be unsuccessful in Europe, some of the operations in Spain and Italy were shut down.

Rio Tinto acquired Alcan, which further increased its production capacity. As Alcan had already owned Pechiney, Rio Tinto Alcan became the world leader in electrolysis technology.

As Western European producers slowly lost ground during the 2000s, the North American producers are now facing new challenges from emerging markets, such as Russia, China and the Gulf countries. The increased production volumes and shares of the total global output are represented in Table 11.

Table 11: New technology suppliers, their production and share of global output [25, 26]

Country	Production (kt/year)	Share of global output (%)
China	25.1	46.2
Russia	4.1	9.7
Gulf countries	3.8	9.1

Table 12 provides a comparative look at some of the North American and emerging market producers.

Table 12: Major players in the global aluminium market in 2010s

Parameters	ALCOA	Rio Tinto Alcan	China	RUSAL	DUBAL
Cell type	817	AP-35	Q-350	SR 300	D18
Current, kA	320	350	350	300	350
Current efficiency, %	95	94.5	94.5	95	96.1
Cell production, kg Al/day	2,448	2,664	2,664	2,318	2,704
Cell voltage, V	4.37	4.3	4.24	4.25	4.21
Energy consumption, kWh/t Al	13,725	13,561	13,372	13,333	13,100
Net anode consumption, kg/t Al	405	415	415	420	410
Number of risers	5	5	6	5	5

The technical parameters listed in Table 12 clearly demonstrate the rise of new challengers to Rio Tinto Alcan originally Pechiney's state of the art AP-35 technology. It is imperative to mention that 80% of the investment costs of a new aluminium smelter are priced at the international level as the factors of production are independent of local conditions [27]. Based on magnetic and thermal model calculations carried out by these competitors over the years, improved cell construction and operational efficiencies were realized [28].

All the technologies described in Table 12 have the following characteristics:
• electrolysis cells are compensated magnetically, the typical values of the vertical component of the magnetic field is 2-5 Gauss;
• transversal layout (side by side) of cells in the potroom;
• process controls and alumina point feeding;
• the transport of aluminium fluoride and alumina to the cell's alumina and AlF_3 tanks using "super dense phase" technique;
• dry-gas cleaning by sandy-type alumina;
• electrolyte composition containing excess of AlF_3;
• use of multi-function cranes to change prebaked anodes, metal-electrolyte tapping;
• controlled heat loss in cathode assembly in order to achieve the proper freezing shape.

c. Emerging markets

China has developed its own technology and has built its own smelters. The Q-350 can be regarded as one the most advanced technologies with its "six risers" pots [29]. China is also planning to add 10 million tons/year production capacity country-wide.

Fig. 10 Q-350 is the first Chinese-developed cell design with six risers

Fig. 11 Typical Chinese potroom

Russia also developed its own technology. RUSAL uses the RA-300 and SR-300 cells in its Bogushan and Khakas smelters. DUBAL in the Arab Emirates has developed the DX + cell technology and operates it in the EMAL smelter. New smelters were also established in Saudi Arabia and Oman, however, these use Rio Tinto Alcan technology.

6. Future outlook

Rio Tinto Alcan continued to develop the AP-50 500 kA current cells. Based on the initial trial runs, the following parameters were achieved [30].

Table 13: AP-50 production parameters

Parameters	Value
Current	500 kA
Cell production	3,825 of Al/day
Current efficiency	95%
Cell voltage	4.25 V
Energy consumption	13,500 kWh/t Al
Net anode consumption	410 kg/t Al

Numerous design issues had to be addressed and resolved during the development of the 500 kA cells. The increase in the size of the cells leads to a more robust anode structure. One of the possible solutions to reduce the weight of anode structure is the separation of the anode assembly into two parts through a flexible connection.

Due to the higher current, the heat has to be “drained” from the structural elements, primarily from inside the cathode. To this end, a more heat conductive, graphitized cathode block and a conductive silica-nitride had to be installed in the side wall. Controlled cooling of the cathode must be ensured so that a sufficient freezing profile can be created in the cells to reduce the horizontal current in the molten metal [31, 32].

Despite the fact that the productivity of the cell and the current efficiency during normal operations reached 95%, the energy efficiency of the electrolysis process is still around 50%. The energy efficiency is defined as the energy used in the cell to produce aluminium compared to the total energy consumption. As such, in order to increase energy efficiency, there are two options: either to increase the current efficiency or to reduce the cell voltage. Currently, according to trial run results, voltage of 3.7V and current efficiency of 97% can be achieved. However, these results may not provide a substantial increase in energy efficiency [32].

In the future, greater emphasis will be placed on recovering heat losses so as to improve the energy efficiency of the electrolysis process. There are two possibilities: one is the utilization of the heat content of anode gases and the other is the heat recovery from the cathode surface. It is estimated that at energy efficiency levels of around 50%, savings of 2,200-2,500 kWh/t Al could be realized [33].

Recent analyses of the magnetic forces and the results of the thermal models also indicate that there is a potential to develop a 750 kA cell in the very near future.

7. Summary and conclusions

Reviewing the 125-year history of the Hall-Heroult process, it can be concluded that the process endured the test of time. The fundamental principles established by the two inventors have not been significantly altered throughout the years. The operational and technological aspects of aluminium production have been improved and refined.

The Söderberg method revolutionized the aluminium industry in its early stages. While such smelters are still operational, the pre-baked anode technology has largely replaced the Söderberg model and is now the most widespread production method. The point feeding of alumina, the dry gas cleaning method as well as the transversal layout of the cells are just some of the key developments in production methods over the past few decades. With the advent of mathematical modeling and expert systems, magnetic forces were mapped and thermal models of the cells could be created, which provided tremendous help in the construction of high amperage cells [30]. The next technology will likely to be the development of the first 750 kA cells, which are expected to be built in seven or eight risers busbar construction [31].

Aside from the technological and operational developments, the global aluminium industry has undergone significant regional and ownership changes as well. While Western European and North American players dominated the industry during the second half of the 20th century, the emergence of China, Russia and the Gulf countries as metal producers poses a significant threat to the traditional producers.

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ICSOBA MATTERS

During the Zhengzhou conference a new structure of ICSOBA management with Honorary President and executive Directors was proposed. The Honorary President will come from the host organization and will be elected annually. His role is to facilitate support by the host organization and to increase visibility of ICSOBA. For 2015, Dr Ali Al Zarouni of Emirates Global Aluminium (EGA) has been elected Honorary President of ICSOBA. Andrey Panov, Alexandre Gomes, Michel Reverdy, Li Wangxing and Frank Feret complement the new Board. The Directors will jointly assure responsibility for the organization and have assigned duties. Frank Feret will remain the external contact for ICSOBA. György Bánvölgyi continues as the Newsletter editor and Dipa remains the secretary. Composition of the new **Board of Directors** is given in the table below:

Who	**Association**	**Position**	**Email Address**
Ali Al Zarouni	Emirates Global Aluminium	Honorary President	ali_alzaroni@dubal.ae
Frank Feret	Analytical Consultant	V-President, CEO	feretfr@gmail.com
Andrey Panov	Rusal	V-President Administration	Andrey.Panov@rusal.com
Alexandre Gomes	Votorantim	V-President	alexandre.gomes@vmetais.com.br
Michel Reverdy	Emirates Global Aluminium	Program Director	michel.reverdy@hotmail.fr
Li Wangxing	Chalco	Director	wx_li@chalco.com.cn

ICSOBA is proud to have invited Dr Ali Al Zarouni to become Honorary President for 2015. Following the conference in Zhengzhou the title has been introduced for the first time in the 51 year history of ICSOBA. Our intention is to recognize accomplishments and highlight individual who earned this elevated position in the organization, which became host to the ICSOBA conference. Another objective is to recognize the importance of the host organization, EGA, among the industry leaders. We all believe that Dr Zarouni justly disserves the title. There are no routine duties attached to this position, or executive power. However, Dr Zarouni will open and close the Dubai conference.

At the Zhengzhou conference, Marja Brouwer has definitely stepped down from the ICSOBA Board and Jeannette See did so as well prior to the conference. Marja and Jeannette, who have dedicated their time and energy to ICSOBA over the years, merit our enormous admiration and thanks for their accomplishments. They will be terribly missed. Good luck with your future plans!

Due to a less visible than expected impact of the council over the years the old council was dissolved. The individuals who agreed to become program organizers form a new council. Among them we have:

Xiangqing Chen (Chalco), Roberto Seno (Votorantim), Steve Healy (RTA), Vinko Potocnik (EGA), Victor Buzunov (Rusal) and Matthieu Arlettaz (R&D Carbon).

There are also nine session organizers among the present council members:
S. Sankaranarayanan (Hindalco), Denis Audet (RTA), Uwe König (PANalytical), Reinhard Bott (Bokela), Andreas Koschnick (Outotec), Paul Hamil and Wagner Brancalhoni (Hatch), Ted Beekman (WEIR GEHO), and Len Lawrence (Nalco Ecolab).

The list of council members will be updated every year.

ICSOBA Past Presidents

NAME	PERIOD OF SERVICE	BOARD OF DIRECTORS(1)
1. Jean Papastamatiou	1964 - 1969	
2. György Dobos	1969 - 1973	
3. Jean Nicolas	1973 - 1978	
4. S.S. Augustitis	1978 - 1983	
5. Ivan Jurkovic	1983 - 1988	
6. Adolfo J. Melfi	1988 - 1993	
7. György Komlóssy	1993-1998	
8. Peter Paschen	1998-2003	
9. Dimitri Contaroudas	2003 - 2008	
10. Roelof den Hond	2008 – 2011	
11. Frank Feret	2011 - 2014	Frank Feret, Andrey Panov, Marja Brouwer, Jeannette See, Li Wangxing
12. Ali Al Zarouni (2)	2015	Frank Feret, Andrey Panov, Alexandre Gomes, Michel Reverdy, Li Wangxing

(1) - The Board of Directors appeared in the ICSOBA structure after the 2011 conference in Goa, India and corresponds to ICSOBA formal registration in Canada.

(2) - Elected as ICSOBA honorary president for 2015.

ICSOBA Medals

On the occasion of the ICSOBA 50th anniversary last year, the Awards Committee decided to produce commemorative pins and medals (see the Figure below). The pins were distributed to all ICSOBA participants of the 2013 conference in Krasnoyarsk. Six medals were awarded in Krasnoyarsk (Dr György Komlóssy, Dimitri Contaroudas, Prof. Dr Peter Polyakov, Dr Viktor Buzunov, Dr Andrey Panov and Marja Brouwer). This year in Zhengzhou four medals were awarded to: Roelof Den Hond (past president), Prof. Dr Li Wangxing, Dr Jeannette See and Gyorgy Banvolgyi. Since 2013 two medals were given each year to the visited plants as token of appreciation for hosting ICSOBA delegates.

From the left: Roleof den Hond - former President; György Bánvölgyi – Newsletter editor and Li Wangxing receive Gold medal from Frank Feret, President of ICSOBA. Below is Jeannette See – Secretary General who could not attend the conference.

As in the past, the "ICSOBA Commemorative Medal" constitutes a special award and may be awarded to not more than a few persons on the occasion of ICSOBA International Meetings. The medal may be awarded to those members of ICSOBA who achieved significant scientific or practical results within the field of action, or who notably strengthened its organization or promoted its international scientific and industrial cooperation. The name of the awarded person is to be inscribed on the medal, and the awarding event should be published in the NEWSLETTER. The "Commemorative Medal" does not carry any pecuniary reward.

Major highlights of the last three years corresponding to the outgoing administration

- At the 2011 ICSOBA symposium on Bauxite Residue in Goa, India a decision was made to incorporate ICSOBA in Canada. ICSOBA site has been moved from Nagpur, India to Montreal, Canada. ICSOBA has been legally incorporated with the Canadian federal government and with the Quebec provincial government. Founding directors were: Frank Feret, Jeannette See, Andrey Panov, and Marja Brouwer. Later, Li Wangxing was added to the board of directors in 2012. The most important legal consequence is that ICSOBA must respect the corporate law of Canada
- ICSOBA's new bank account was opened in the province of Quebec. The money remaining in India at the end of 2011 was successfully transferred to Canada. ICSOBA PayPal account was also established
- A chartered accountant in Quebec was assigned to the task of verification of ICSOBA accounting and preparation of legal documents required by law
- Secretarial services have been assured contractually (Dipa Chaudhuri)
- Three major conferences were organized: Belem (2012), Krasnoyarsk (2013) and Zhengzhou (2014)
- A new ICSOBA website was built and is constantly updated
- Six NEWSLETTERS were issued and distributed to members
- TRAVEAU volumes corresponding to the last three conferences were published
- ICSOBA proceedings, the TRAVAUX volumes, from past conferences and symposia (since 1963) were electronically scanned and are available for members as searchable pdf files
- 300 small pins with ICSOBA logo and 55 bronze-based anniversary medals were designed and manufactured
- The council was expanded by additional members and its composition was revised twice
- ICSOBA bylaws were thoroughly revised and adopted to the needs of Canadian legislature. Payment policy was also updated every year as a document linked to bylaws
- Three different communications highlighting ICSOBA and its mission were presented at external conferences to publicize ICSOBA (at Non Ferrous Metals of Siberia – 2012, Metal Bulletin - 2013 and ARABAL – 2013). Seven articles were published in several international journals
- ICSOBA entered into bilateral agreements with ten media partners

Corporate Members

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Internal organisation

The International Committee for Study of Bauxite, Alumina & Aluminium is an independent association that unites industry professionals representing major bauxite, alumina and aluminium producing companies, technology suppliers, researchers and consultants from around the world.

ICSOBA belongs to its members and since the members elect the Board of directors in the Annual Meeting during an ICSOBA Event, members determine the policy of ICSOBA. ICSOBA currently has 238 members.

Membership

ICSOBA provides members with a platform to exchange technical information with each other. Upon their request individual members who are consultants or advisors to the aluminium industry, will be enlisted on the designated Consultants page on the website.

Companies can support ICSOBA by becoming Corporate member. Corporate members are shown in every Newsletter and listed on ICSOBA's web site. Corporate members can nominate two employees who have the same rights as individual members, such as reduced event delegate registration fee, Newsletters and voting rights. Digital proceedings can be made available to all employees at the company's intranet, and corporate members can sponsor ICSOBA events at the reduced sponsor fee.

	INDIVIDUAL MEMBERS	CORPORATE MEMBERS
Reduced Sponsor rates at ICSOBA Events		Yes
Reduced delegate registration fee for ICSOBA Events	Yes	Yes for 2 nominated employees
Name listed in ICSOBA's website	In Consultants page upon request	In Corporate Members page with link to web site
Right to vote on ICSOBA matters and eligibility for Presidency and Council	Yes	Yes for 2 employees
Receive a digital copy of a full paper or full proceedings of a past ICSOBA Event	Upon request	Upon request
Biannual Newsletter with articles from members, news and statistics	Yes	Yes to 2 employees. Company mentioned in Newsletters
Annual fee (from July to July)	C$ 100	C$ 750

You can find an application form for individual membership and corporate membership on ICSOBA's website. You can also renew or apply for individual membership together with your registration for an ICSOBA event.

Public relations and Communication

Website

Printed proceedings of past ICSOBA events, the so-called Travaux volumes, have been scanned to separate searchable pdf files. There are a few exceptions, these are being searched and scanned as soon as possible. The Tables of Contents of the scanned Travaux volumes have been made public on the website http://www.icsoba.info/downloads/proceedings-of-past-events. ICSOBA members can obtain digital versions up to 20 papers each year at no cost by sending an email request to Dipa icsoba@icsoba.info. Additional papers are charged for C$ 20 each.

Your feedback to make the website more attractive is welcome.

ICSOBA's executive office

Not only requests for past proceedings, but all inquiries sent to ICSOBA, whether by email to icsoba@icsoba.info or by phone to + 91 982 328 98 17, are addressed by Ms. Sudipta (Dipa) Chaudhuri in Nagpur, India.

Also mailings and the underlying database of ICSOBA's contacts are taken care of by Ms Dipa Chaudhuri in the executive office.