Essential Readings in Light Metals: Aluminum Reduction Technology.
Edited by Geoff Bearne, Marc Dupuis and Gary Tarcy.

From ***Light Metals 1986***, R.E. Miller, Editor

ALUMINIUM PECHINEY 280 KA POTS

B. Langon and P. Varin

Aluminium Péchiney

St-Jean de Maurienne, France

As a result of four years of extensive tests carried out on four prototypes, the St-Jean-de-Maurienne Research Laboratory has perfected a new model of reduction pot.

Developed with the help of advanced computer models, this new generation of industrial pots functions with a nominal amperage of 280 kA, a current efficiency of 95 % and a DC power consumption of 12 900 kwh/T. These results as well as the different measurements taken on the operating prototypes are in complete agreement with the predictions of the models.

A first potline of 120 pots is currently in the start-up phase at the St-Jean-de-Maurienne plant.

INTRODUCTION

From 1975 to 1980 the Pechiney Research Centre at St-Jean-de-Maurienne (L.R.F.) concentrated its efforts on the design, testing and perfecting of the 180 kA pot. Several potlines have been built using this technology since the 60 pots of the F Line were started at the St-Jean plant and pots operating in the World to date total more than 900 and should exceed 2 100 by the end of 1989.

In 1981 it was decided to work on a new generation of point feeding pots, using the same two-phase development method followed by a third full scale industrial implementation, which led to the success of the 180 kA Pechiney pot and has been described in a previous presentation to AIME in 1982.

Phase 1 : Design and construction of four prototypes and definition of the industrial pilot pot carried out at the L.R.F.

Phase 2 : Testing and development of the pilot pots at the L.R.F.

Phase 3 : Construction and operation of a fully industrial facility as a potline of 120 pots at St-Jean-de-Maurienne.

The major objectives were the following :

- to improve productivity and the degree of automation of the process,

- to attain an energy consumption of less than 13 000 kwh/MT in industrial potlines,

- to build potlines with a production range which complements that of the 180 kA pots.

These led us to conceive our 280 kA pot.

ECONOMIC IMPACT OF POT SIZE

The larger size of the 280 kA pots gives advantages in specific investment cost (per tonne per year) :

- the ratio "building surface" to "pot surface" decreases,

- the pot tending and process control equipment required is correlated to the pots regardless of their size.

These advantages are partially offset by the higher cost of more sophisticated parts (e.g. Anode suspension system).

The operating cost is also improved by pot size due to higher labor productivity.

On the other hand the size of a new reduction facility is defined by the power availability on the site, the investor's financial capability and the metal requirements.

For a given technology and nominal amperage a maximum number of pots is connected to the substation in order to reduce the specific investment (per ton per year). 240 pots per potline with a total voltage of 1 000 DCV is a common practice due to safety limits.

With the 180 kA pots the specific investment cost of one potline remains close to optimum between roughly 160 and 240 pots (i.e. 80 000 to 120 000 MT/per year). For two potlines, a range from 400 to 480 pots results in similarly minimized specific investment costs (i.e. from 200 000 to 240 000 MT/per year).

The same ranges, in terms of number of pots per potline, apply to the 280 kA pots and result in optimized production capacity between 120 000 and 200 000 MT/per year and may be relevant for producers interested in that range or beyond 300 000 MT/per year.

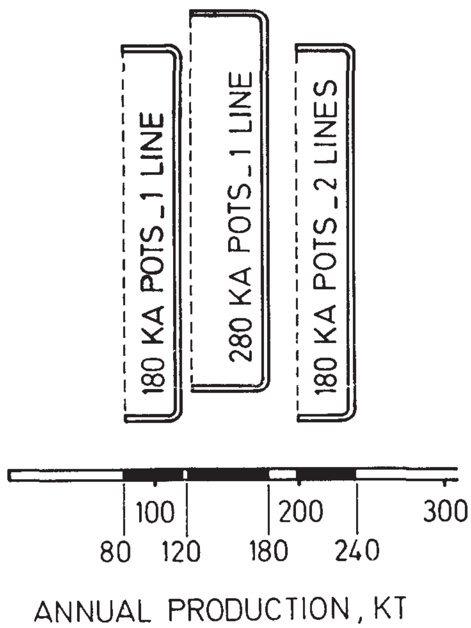

Figure 1 - The size of the plant is determined by the nominal amperage of the pots.

POT DESIGN

The conceptual design of a new generation of pot is based on the use of mathematical models. These models allow the design, in an increasingly more accurate way, of pots which are thermally and magnetically stable as well as the construction of a good prototype at the first attempt.

Our mathematical models have been well-tested by the experience acquired with the 180 kA pot and have proved to be perfectly adaptable with an amperage of 280 kA. Only a few adjustments had to be made to the pots during the full scale experiments carried out at the L.R.F.

Magnetic and magnohydrodynamic models

The magnetic fields were calculated and corrected in such a way as to obtain the maximum stability of the metal pad, taking into account all the modifying effects of the surrounding ferromagnetic structures. The use of a magnohydrodynamic model in order to minimise the effect of a horizontal current disturbance in the metal pad guarantees stable pots at anode changing and in the event of cathode cooling. The busbar circuit is slightly dissymetrical to correct the detrimental effect of the adjacent row of pots.

Thermoelectrical model

In order to reduce energy consumption it was decided to build a pot with a current density lower than in the 180 kA pot. The thermal insulation of the lining has been slightly increased to match a current density of 0,74 A/cm2.

The natural forming of the bath ridge and the optimum location of the isotherms in each of the materials are fundamental in order to ensure long pot life and sufficient thermal stability. A thermoelectric calculation permitted the definition of simple and economical lining designs which meet these requirements and can be differentiated by the nature of the insulating materials used one with conventional materials, the other using highly insulating panels.

PROTOTYPES - PHASE 1

The aims of Phase 1 were to :

- select the lining design

- decide the advisability of individual movement of anode assemblies.

Four prototypes were set up in 1981, in the special potroom previously used for the development of the 180 kA pots, with an independant substation and fume control system. The air flow from the closed building is controlled in order to enable continuous monitoring of emissions.

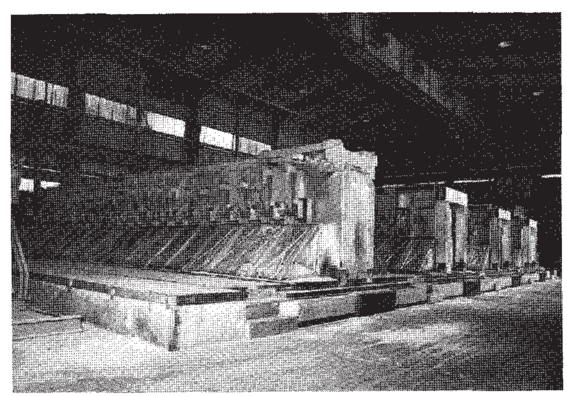

Figure 2 - Four prototypes 280 kA pots were tested in the LRF's experimental potroom.

The alumina is transported to the pots by a very reliable horizontal conveyor with potential fluidisation. Feeding is carried out by computer controlled crustbreaker/feeder assemblies.

Individual movement of the anode assemblies

To improve productivity, anode changing is carried out in pairs. On the first prototypes it was possible to adjust the level of each of the 20 anode pairs individually by means of 20 adjusting jacks attached to a common main beam. Overall movement of the anode system by means of the main beam also permits conventional adjustment of anode level (See Fig. 3).

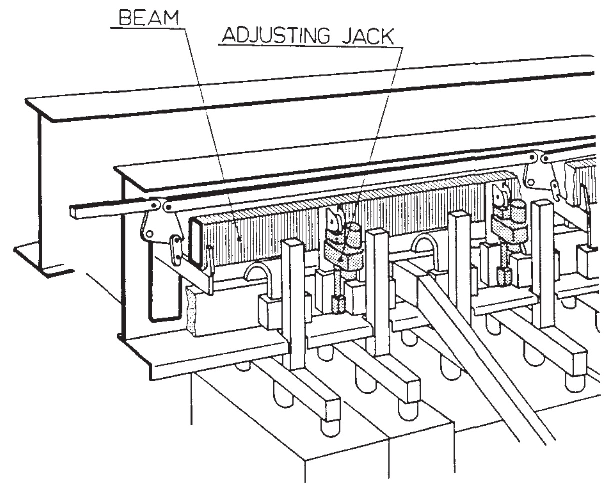

Figure 3 - Anode assemblies can be adjusted all together by means of the main beam or by pairs by means of the individual adjusting jacks.

We operated at the same time two pots with individual adjustment of pairs of anodes and two pots with overall adjustment. The advantageof individual adjustment is the elimination of the necessity for manual correction on imbalanced anodes, by means of basic automated process control procedure. The drawback is a substantial increase in superstructure cost.

With overall anode adjustment, the number of manual corrections on anodes was initially substantial (0.7 per pot and per day). This number was rapidly reduced to 0.3 and then to 0.1 per pot and per day by adapting the procedure for anode changing and by improving automated process control. These improvements led to the abandon of individual anode adjustment.

Pot N° 4 was rebuilt in May 1983 without the possibility of individual anode adjustment which considerably reduces the cost of the pot superstructure and simplifies automated process control.

Choice of lining design

Two lining designs were compared, resulting in satisfactory thermal balance. The choice was made observing the behaviour of the materials throughout their aging in the pot. Two prototypes were stopped in 1983 and the dry delining of pots 4 and 3 in April and November 1983 showed the carbon crucibles to be in excellent condition. However, the highly insulating panels located in one of the linings showed signs of damage and has been attacked in several places.

It was decided to apply the conventional solution of using refractory and insulating bricks which are, moreover, giving good results on the sixty 180 kA pots in the F line where only one pot was stopped due to ironing after almost six years of operation.

PROTOTYPES - PHASE 2

The aim of the second development phase, started in 1983 was to test the prototypes industrially, as far as possible, in order to :

- perfect automated process control
- test different bath compositions,
- finalize the work schedule on pots.

Control of alumina feeding

This method of control, which was already successful on the 180 kA pots with a current efficiency of 94-95 %, was improved. Current efficiency of the prototypes was never less than 95 % as from the beginning of 1984. The alumina feeding control method is based on the monitoring of variations in pot resistance. These variations, which are related to the amounts of alumina fed to the pots, enable to evaluate the instant alumina content in the bath. Fig. 4 shows the results obtained from samples taken in two different operating conditions with target alumina content of 2 and 3 %.

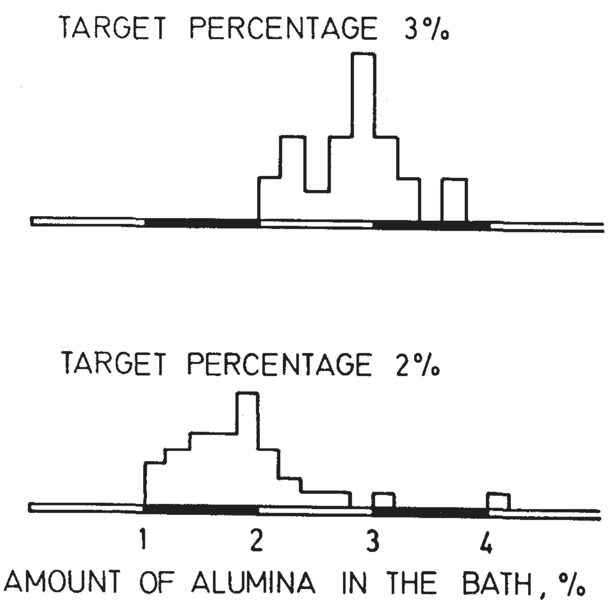

Figure 4 - The alumina feeding control system ensures that the amount of alumina in the bath is near the target percentage required.

Lithic bath tests

During this development phase in 1984, the influence on the technical results, of the addition of lithium to the bath, was evaluated.

For nine months, pot N° 2 was connected to a booster rectifier group and the bath composition modified. Three different compositions were tested and both the rate of LiF and AlF3 were changed, giving the following results :

Table I. Technical results obtained by testing 3 different Lithium baths

		Bath 1	Bath 2	Bath 3	Ref.
LiF	%	2,6	3,0	2,1	0,4
Excess AlF3	%	7,7	9,5	11,2	12,5
Temperature	°C	953	942	937	952
Current efficiency		91,9	94,1	95,1	95,8
Voltage	V	4,11	4,13	4,16	4,13
Kwh/MT		13 320	13 060	13 030	12 840
Amperage	A	281 000	284 300	285 600	281 700
Daily production	kg	2 080	2 156	2 186	2 174

These results, obtained on stable pots without any operating problems show a decrease in the technical performances which contradict the conclusions drawn from similar tests on other types of pots. Consequently, the addition of lithium cannot be justified economically or technically when current efficiency exceeding 95 % is achieved without its use.

Working conditions

Numerous measurements were taken to evaluate pot working conditions.

The average temperature between the pots never exceeds the temperature outside by more than 10° which ensures good working conditions.

Fume control efficiency, measured frequently on the prototypes, is excellent and exceeds the regulation limits in force.

Technical results

These results are shown in Fig. 5 for both Phase 1 and Phase 2.

By the end of 1984 pot operations was satisfactory in every respect with a current efficiency exceeding 95 % and a power consumption of less than 12 900 kwh/MT.

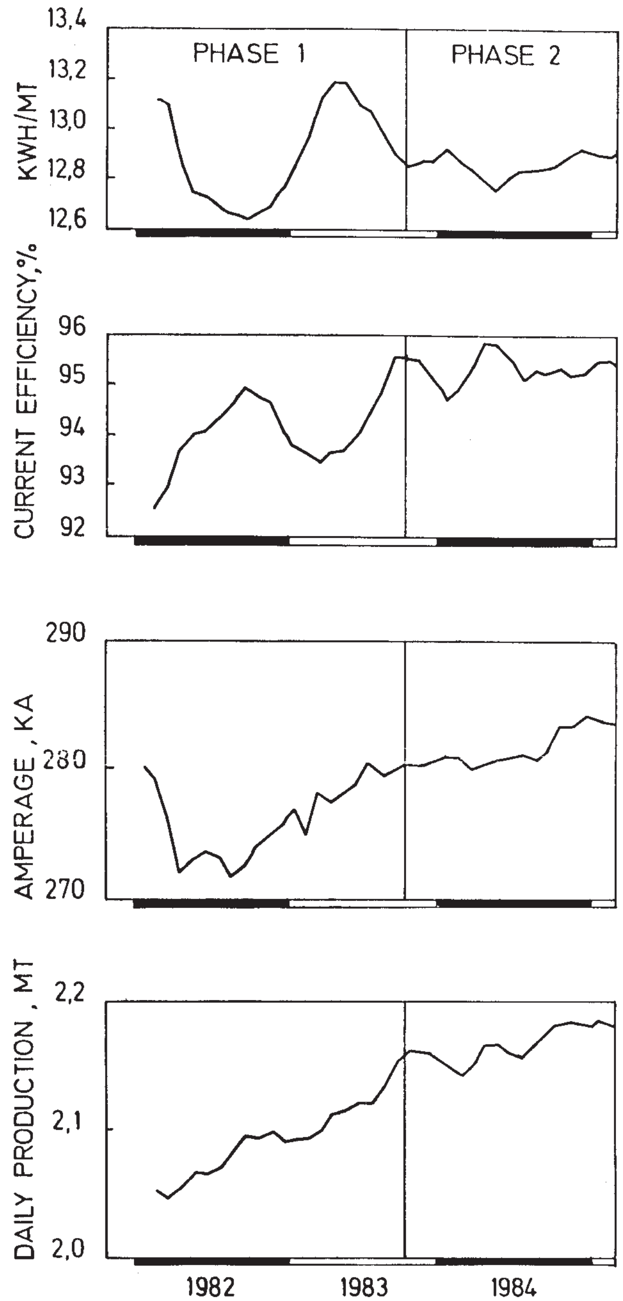

Figure 5 - Technical results of 280 kA pots.

PHASE 3 - G LINE

At the end of 1983 the decision was made on the basis of the initial results to install hundred and twenty 280 kA pots in the St-Jean-de-Maurienne plant. This initiative is part of a modernisation programme, started in 1978 with the construction of the F Line, which includes shutting down the old potlines and expanding the Casthouse and Anode Plant.

The G Line is being built as an extension of the 60 F Line pots presented to AIME in 1982. The center-to-center line of the two rows of pots is 54 m, and that of two adjacent pots is 6 m, which makes for a compact line.

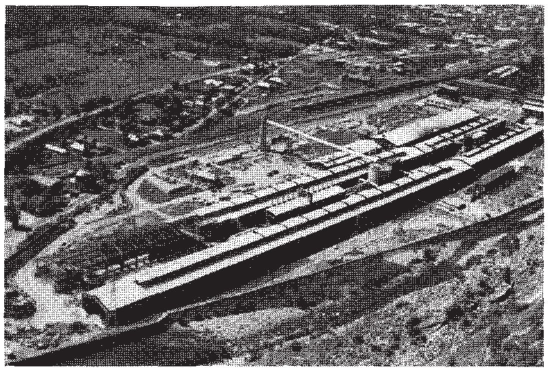

Figure 6 - The G Line in St-Jean-de-Maurienne is being built as an extension to the sixty 180 kA F Line pots.

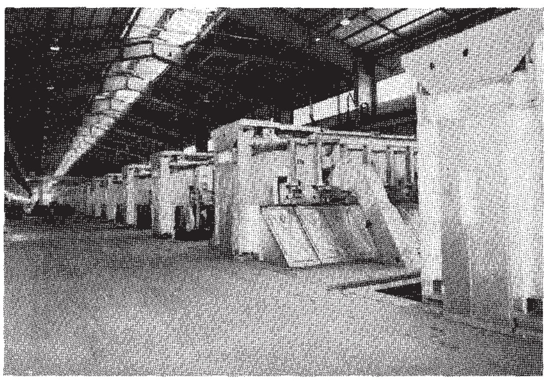

Figure 7 - There are one hundred and twenty 280 kA pots in the G Line.

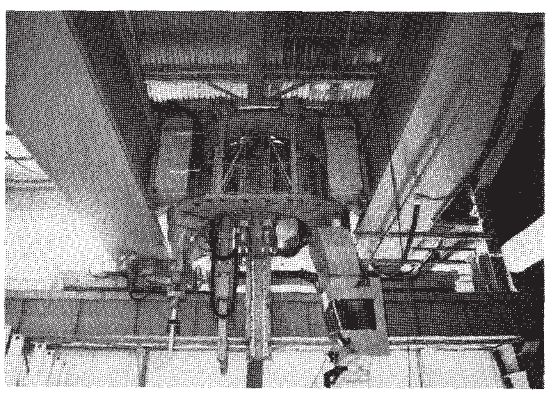

Figure 8 - The ECL pot tending assembly comprises a cabin which turns around the tool holder turret.

The Pot Tending Assemblies are of a new multipurpose type, built by E.C.L. which allow easier access for maintenance. Turning around a tool-holder turret the cabin gives good visibility and greater comfort. Eight pot operators are sufficient for tending 120 pots (94 000 MT/year).

The start-up of the G Line, scheduled for September 1985, has been postponed to 1986 due to the present metal market situation.