Proceedings of Iran International Aluminum Conference (IIAC2012)
May 15-16, 2012, Arak, I.R. Iran

Retrofit Upgrade of Center Break Cell Technology to Point Feeding Cell Technology Implementing Required Mechanical and Automation Changes

Borzu Baharvand , Mohammad Nabi Batoei, Hassan Goodarzi, Mohsen.ameri
Almahdi-hormozal Aluminum Corporation, Bandar Abbas, P.O. Box: 79171-76385, Iran

Abstract: Aluminium reduction cells have benefited from point feeding technology for a long time, but there are still smelters which are using the old technology of center break and center feed system. Due to several factors this system is no longer approved and there have been a few attempts worldwide to upgrade these cells so as to implement the newer technology by applying mechanical and automation changes. In this paper we will present an attempt which was made in order to retrofit a so-called center break cell to point feeder cell. The results show that this project has decreased the energy consumption and anode effect frequency. Furthermore, there has been a significant increase in current efficiency.

Keywords: "center break, reduction cell, point feeder system, superstructure retrofit"

Introduction

Pot control is provided by PCU2 or PCU3 or PCU3G or DCCU. PCU2 or PCU3 or PCU3G are from ALESA and DCCU is developed by DUBAL. The control is governed by six main software modules: i) Resistance and Noise Control. This consists of following programs: Resistance Control-Noise detection-Noise control-Temporary Resistance Adder Logic-New Pot Resistant Adder Logic-Anode Setting Logic-Tapping Logic ii) Break and Feed. This consists of the following programs: Scheduled Break and Feed-Demand Feed-Starve Logic. iii) Anode Effect Control. iv) Load Control. v) Aluminium Fluoride Addition Tables. vi) New Cell Control [1].

Despite the development and construction of new pot technologies at Dubai Aluminium (Dubal), development and improvement of the original D18 cell technology has been sustained, and continues to play a significant part of the growth and expansion of the company. This paper summarises the progress of the original D18 cell technology at Dubal over the past few years, and its contribution towards the goal of 1 million tonnes plant annual hot metal production Amperage has increased from an original design target of 155kAup to 196kA in 2008. To ensure adequate pot performance is maintained with this increase in production, there has been significant development of the cell alumina, bath chemistry and heat balance control. Other changes such as anode size increase, modifications to the cathode and measures to ensure bus bar integrity have allowed for further planned amperage and production increase over the next five years [3].

ALMAHDI Aluminium Corporation (AAC), once considered a modern plant, is now concerned with the issue of old reduction cell technology which is far away from currently used technologies. The plant which is located near the city of Bandar Abbas, has a total number of 240 reduction cells which utilize center break and center feed systems. The amperage of the production line is 175kA that in comparison with recently installed plant is around the half. After the Iranian targeted subsidy plan in 2010 which aimed to replace subsidies on food and energy with targeted social assistance, the price of energy has risen massively. The impact of such noticeable increase on primary aluminium industry was so intense which triggered the production section to review and assess its lavish power consumption and search for inexpensive schemes to retrofit its systems and structures. Therefore, AAC has defined a number of R&D projects Given the successful experience in dubal and hindalco same technologies in order to achieve such goals.

One of the defined R&D projects in AAC was called *"Retrofit Upgrade of Center Break Cell Technology to Point Feeding Cell Technology"*. The project was assigned to an engineering and consulting Iranian company[5].

Model

The scope of the project included mechanical and industrial control and automation alterations and optimizations required in order of converting the existing center break reduction cell to a point feeder reduction cell. Mechanical changes can be categorized into two groups as follows:

a) Off-site mechanical changes

This group of changes includes those changes which could be applied in the repair shop such as sheet metal work, pneumatic jack installation, pneumatic piping installation and ore hopper adjustments. Due to the fact that the superstructure was designed for a center break reduction cell, a few parts had to be deleted such as ore gate and center breaker system.

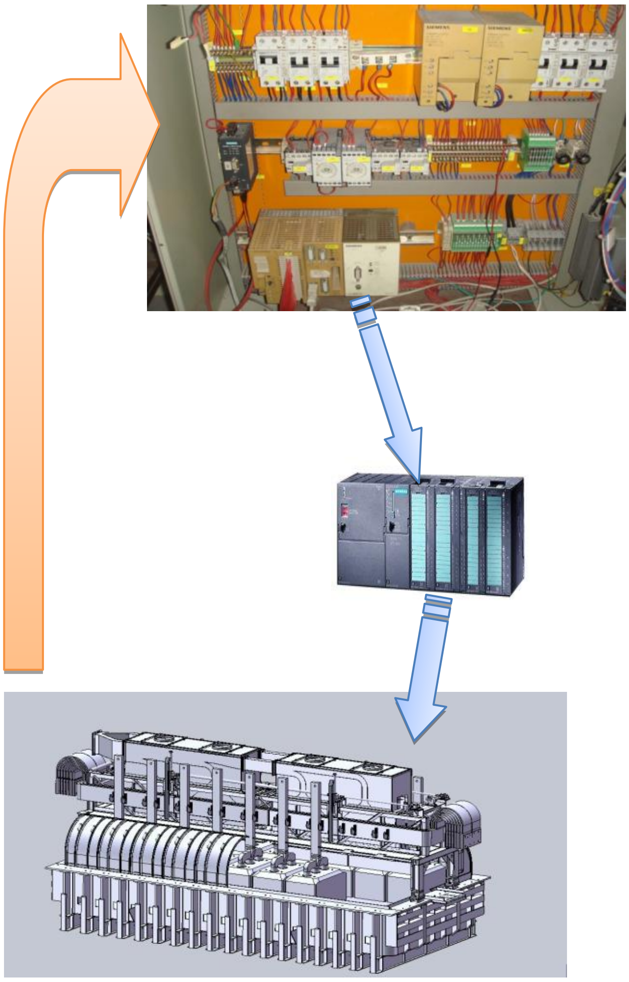

Fig1- Programming and Upgrade PLCs$_5$ to PLCs$_7$

b) **On-site mechanical changes**

The main hardship of the project was that some of the main mechanical changes and modifications had to be applied after the reduction cell was set in operation. This meant a working atmosphere with high temperature, intense magnetic field and sometimes alumina dust. For example, welding process was hindered by the considerable magnetic field inside pot room.

Fig2 – pot with Center work(breaker)

Fig3 – pot with point feeder

Results and Discussions

Improvement of Technology

The aluminium reduction cell's technology of D18 kind from Almahdi Aluminium Company of dubal with pre baking anodes per pot 18 anodes, is designed based on the Kaiser P69. These cells on the basis of ground surface have installed side by side.

To improve productivity and reduce the costs through decrease of energy consumption and enhance of control system and feeding, some studies done on similar D18 technologies and by using its experience for promoting the recovery pots and also the control system of Dubal aluminium production pot, introduced some changes on one of the Almahdi's pots which in this article described in details.

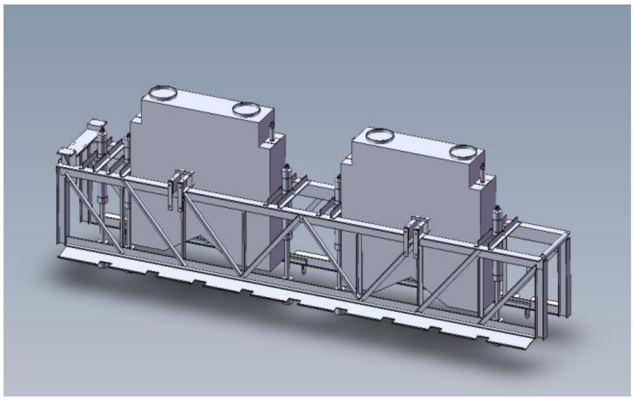

Fig4- Simulation and Modeling super structure Almahdi Aluminium Smelterand modified to become a point feed

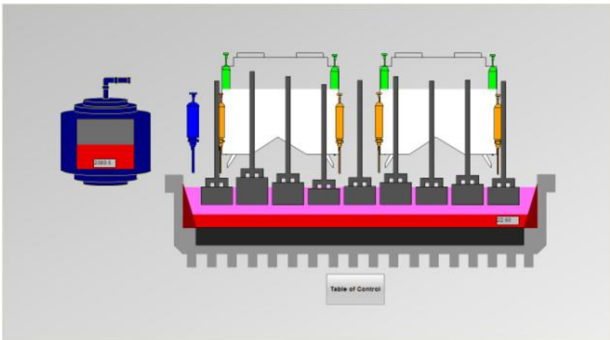

Fig5- Pot Simulated

Alumina Feed

In the current pots, alumina feeding through breaking the middle line of hard crust performed by cortex breaker jacks. In this method, there is no good control on the added alumina and while loosing much heat from central channel, also large amount of hard solid crust, by breaking in each time, entered to molten bath and as an impurity disturbed pot's stability. Almahdi company by allocation of experimental pot and change of feeding system to point feeding, through increase of alumina covering on the anodes, metal surface reduction and some changes in bath chemistry, decreased heat waste the in turn reduced the voltage of pot and electricity consumption. Also in this system, occurrence of anode effect significantly reduced and alumina usage was controlled better which resulted to the decrease of sludge(Sludge)on the pot's cathode. Feeding program according needs contains four stages including: base feeding program, little feeding program, much feeding program and medial feeding program which amount of feeding and alumina feeding time in each stage is different. The algorithm of feeding has shown in figure 3.

Property	**Unit**	**Center Work**
Time between two feeding	min	60
pot temperature	°C	970
Discharge mass	Kg	100
Anode effect frequency	AE/pot.day	0.75
Current efficiency	%	90.6
Pot voltage	V	4.96
Power consumption	kWh/ton Al.pot	16.4
The amount of carbon dioxide	%	1.4
The amount of carbon monoxide	ppm	1650

Table1- Compare the Operation between Center Work pot and Point Feeder pot

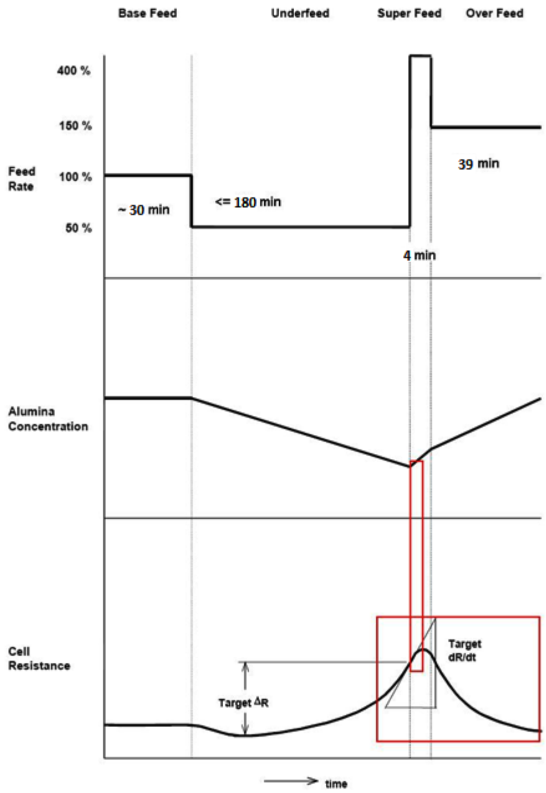

Fig6 – Adaptive Feed Control Strategy

control system

In software system, the local control of present pots, the voltage setting in two different phases is done by anode's motion and failing and central canal feeding which by induction of some changes and covering the algorithm of intelligent feeding control, based on need and anode's simultaneous motion in phase 4 has been shown. In figure 3, the process of pot's feed appears. In following for pot's local control system compatibility with present system in level 2 some changes imposed in other software parts and also some adjustment in hardware which finally as a result of applying feeding algorithm as required, it is provided to change bath chemistry and working conditions that its results has shown in table 1.

Property	**Unit**	**Point Feeder**
Time between two feeding	min	3
pot temperature	°C	962
Discharge mass	Kg	4.4
Anode effect frequency	AE/pot.day	0.21
Current efficiency	%	93
Pot voltage	V	4.56
Power consumption	kWh/ton Al.pot	14.6
The amount of carbon dioxide	%	0.5
The amount of carbon monoxide	ppm	551

Table2- Compare the Operation between Center Work pot and Point Feeder pot

Operating conditions and Bath Chemistry

In point feeding 4 small holes at the feeding point along the central line created and 4.4 kg alumina in each feeding added, the crust breaking and feeding is done separately by two compressed air cylinders. The most important advantage of point feeding is that the concentration of alumina in bath remained almost constant and the least failure occurred in upper crust and causes the process work optimally in constant condition and so pot's yield would be increased. The feeding site in point feed, should be a where that from which alumina enter to the inside of the pot and bath in that point have the most speed, so the best place is the middle channel close to anode's corners. It should be noted that in the point feeding a created hole in the hard crust must be remained till in each time of breaking, the new cracked crust not broke in bath that this operation in this system is practical. Average temperature in the central feed system 970° C and in the new feeding system is about 962° C . Additional aluminium fluoride levels of about 8% and that average pot voltage is 4.56 V . The height of molten metal, 4 cm decreased and this one resulted to reduction of pot's resistance, working average voltage, anode effect frequency and finally energy usage and increase of flow yield 3 present. In tables 1and2 it is offered a comparison between Almahdi's present pots performance with central feeding and new pot with point feeding system.

Conclusion

The results show that by changing feeding system to point feed mode and control of pot through feeding program based on need, without major changes in current automation system and improvement of some practical condition, the height of molten metal 4 cm decreased and by changes of additional fluoride aluminium mount can reach to 962° C of pot temperature, and voltage sup to about 4.56 V cut and the annual consumption of electricity through16.4 kWh/kg-from Al reached to 14.6 kWh / kg-Al. It should be note that now 2 executive projects are under way for improve of pot's operational conditions and also for promoting the central control system, recovery of control and pot feeding algorithm by using modern methods which promise the availability of technology and intelligent control of recovery pots through advanced methods and high benefits in aluminium industry in near future.

References

[1] A.J.M, Kalban., Aluminium smelting technology at doubal, 1rd Ed., Aluminium-Verlag, 1993, pp. 200-230.

[2] K, Grjotheim., H.Kvande.,Introduction to Aluminium Electrolysis , 2rd Ed., dubai U.A.E, 2006, pp. 325-410.

[3] D.Whitfield, A. Al-Monien Said, “Development of D18 cell technology at dubal”, Light Metals, G. Bearne, Eds., dubi, U.A.E, 2009, 477-481.

[4] S.C.Tandon., R.N. Al-Prasad, “Twenty years of progress at hindalcos aluminium smelter”, Light Metals, P.N.Crepeau, Sonebhadra.,india, 2003, 379-391.

[5] Statistical information derived from operational research R&D Almahdi