CB04 - Impact of Quality Changes in Calcined Petroleum Coke (CPC) on Anodes Used for Aluminium Production

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Abstract

Calcined Petroleum Coke (CPC) has been in use for more than 120 years to produce the carbon anodes used in the Hall-Heroult Aluminium electrolysis process. Performance of the anodes in the aluminium electrolysis process depends on many properties of CPC. It is seen that over the last several years quality and availability of anode grade petroleum coke has been impacted by changes in the petroleum refining industry. Refineries have started using sour crudes that have high sulphur and metallic impurities due to shortage of sweet crudes coupled with high demand for oil. As a result, RPC from refineries are having higher sulphur content and metal impurities. Therefore, smelters worldwide are using CPC with higher sulphur content to meet their requirements. The increasing trend of impurities in CPC used by Indian industry is a major concern for the industry. In this paper, the quality variations observed in CPC used by NALCO and their impact on anode quality is highlighted along with presentation of few R&D studies carried out at NALCO, the findings of which may be helpful to deal with expected future quality changes in CPC.

Keywords: Calcined Petroleum Coke, Anode, impurities.

1. Introduction

Calcined petroleum coke (CPC) is one of the major raw materials for the Aluminium Industry. Like any other raw material, it plays a significant role in the aluminium production process. CPC is used for fabrication of anodes used in the aluminium electrolysis process. Extensive research is taking place since more than 30 years to find an alternative to this material. From the recent reports [7][8], it is evident that though considerable progress has been made in finding right kind of materials for making inert anodes, it may take many years to address the impending problems associated with fabrication and use of inert anodes. Hence today more focus is required on the carbon anodes made out of CPC & coal tar pitch (CTP) for continual improvement of performance of the electrolytic pots producing aluminium metal.

In the present day, the global production of primary aluminium is around 64 Mt, China being the single largest producer of aluminium contributing to 57 % of total world production. The global demand of aluminum has grown at an average rate of 4.5 % in the past five years. If the same trend continues in future, by 2025 the aluminum production will reach a level of about 87 Mt/a. Primary aluminium installed capacity in India is today 4.1 Mt with expansion plans and other development plans in place. Further, the Indian aluminum demand has grown at an average rate of 12 % in the past four years. If the same trend continues in future, by 2025 the Indian aluminum production will reach a level of about 8 Mt/a, which means increasing the production capacities. In accordance to increase of aluminium capacity, requirement of CPC for Indian aluminium industry is going to increase from the current 1.3 Mt to 2.6 Mt. Availability of suitable grade of CPC for anode production is going to be a challenge for the Indian Aluminium industry. There is a shortfall of 92 % CPC with <1.25 % S and 82 % CPC with 2.5 % S in India. It is seen that over the last several years quality and availability of anode grade petroleum coke has been impacted by changes in the petroleum refining industry. The refineries have started using sour crudes that have high sulphur and metallic impurities due to shortage of sweet crudes coupled with high demand for oil.

National Aluminium Company (NALCO) established in 1981 in the state of Odisha has its smelter complex situated at Angul. The plant has been set up in technical collaboration with aluminium Pechiney and operates the AP18 pots in four potlines having total 960 pots augmented with its own carbon plants equipped with most advanced technology producing prebaked anodes NALCO, since its inception has been using CPC of different varieties. This paper focuses on the impact of various properties of CPC on the anode quality. A few R&D studies carried out to find possible solutions to improve anode quality in the face of deteriorating CPC quality are included in this paper.

2. Calcined Petroleum Coke

2.1 Crude Oil to Coke

The choice of crude processed in a refinery is strongly affected by location of crude and refinery design and is normally independent of coke quality considerations. Crude oil has an elementary composition C: (84-87) %, H_2: (11-14) %, S: 0.2 %, N_2: 0.2 % and is a mixture of hydrocarbons which range in boiling points from 0-80 °C. It is distilled under atmospheric pressure followed by a distillation under vacuum. Typical products from a barrel of crude oil are light straight run gasoline 11 %, reformer naphtha 25 %, kerosene 15 %, diesel fuel 10 %, gas oil 10 % and residue-coker feedstock 8 %. The residue is heated to approx. 500 °C and is directed to the bottom of one of the coke drums. Here sufficient retention time (32 h) and temp is provided in order to permit a slow formation of coke (hence the term delay coking).

2.2 Coker Products

1. Shot coke; it is spherical in shape 2- few (25 cm) in size, have high CTE; have a slick shining exterior coating of needle type carbon.

2. Fuel coke; fuel coke has a less optimal macrostructure, has a high coefficient of thermal expansion (CTE). It is the least valuable material in the non-fuel market.

3. Sponge coke; sponge coke or honeycomb coke, the pore structure is more pronounced and CTE is decreased. This is the anode grade coke.

4. Needle coke; it has a characteristic needle like surface. This coke has the lowest CTE and low in metals and sulfur. Most of the graphite manufacturers use this coke.

2.3 Raw Petroleum Coke (RPC) to Calcined Petroleum Coke (CPC)

Raw petroleum coke is calcined to remove excess water and volatile matter in rotary kilns or shaft kilns. Rotary kilns are most widely used for economic reasons. Calcination temps are between (1250-1400) °C. The calcined coke leaving the kiln is discharged into a rotary cooler, where it is quenched with direct water spray at the inlet and then cooled by a stream of ambient air. The calcining operation can have an important influence on coke quality. Cokes with significantly different volatile contents (quality and quantity) and impurity levels should be calcined differently. Calciner process variables affecting CPC quality is given in Table 1.

Table 1. Calciner process variables affecting CPC quality.

Calciner process variable	Effects
Green coker volatile content & how fast the coke is heated.	As the VM increases, coke will experience higher heat up rates which reduces bulk density and porosity increases.
Calcining temperature	Increase in calcinations temperature will increase the coke's real density and reduce the coke's reactivity. (The preferred real density should be where the binder coke reactivity matches the filler coke reactivity). If the temperature is too high, significant quantities of Sulphur in the coke will be released increasing the cokes porosity.
Cooling water quality	Contaminants like Ca & Na will increase the reactivity coke.
Storage transportation	Sizing and storage activities can possibility add impurities.

2.4 CPC to Anodes

Green anodes are made by mixing around (55-60) % calcined petroleum coke, (30-35) % recycled butts along with (14-15) % coal tar pitch and vibrocompacting to 1.25-1.27 T blocks. These green anodes are baked in refractory brick lined baking furnaces to high temperatures (1090-1110) °C anode baking temp) to attain the properties of stable and unreactive anodes for giving stable performance in the electrolysis cells.
The anode manufacturing process involves the following major steps

- Preparation of dry aggregate consisting of various fractions of calcined petroleum coke having different particle sizes & recycled anode butts by crushing, sieving, grinding & proportioning
- Preheating the dry aggregate
- Mixing the dry aggregate with pitch in a mixer
- Vibrocompacting or pressing the green paste to form anode blocks
- Baking the green anodes in refractory lined bake ovens by indirect heating through heavy furnace oil or flue gas following a regulated fire cycle.

Primary aluminium is produced by electrolytic reduction of alumina using the Hall-Héroult processes. Alumina, an oxide of aluminium, is dissolved in a molten cryolite bath at approximately (950-960) °C and electrolyzed in a reduction cell by direct current. Carbon prebaked anodes are used as positive current carriers in production of aluminium and need to be periodically replaced in the cell as they are consumed. These anodes have a lifetime of (24-30) days and the remaining anode butt is cleaned and recycled back in the production of green anodes.

The overall chemical reaction in the aluminium production is summarized as in equation (1).

$$2Al_2O_3\,(\text{dissolved}) + 3C\,(\text{solid}) \rightarrow 4Al\,(\text{liquid}) + 3CO_2\,(\text{gas}) \tag{1}$$

The theoretical consumption of carbon as per the reaction is 334 kg per one ton of aluminium produced. However, the actual carbon consumption is (400-450) kg/t of aluminium produced. The important anode performances include high resistance to oxidation to minimize excess carbon consumption, high density and low permeability, good mechanical strength for structural integrity and handling, low specific resistance values, high elemental purity to avoid contamination in metal and high thermal shock resistance to avoid cell disruptions. Any variation in the properties of CPC are reflected in the quality of anodes if process is not adapted to variations. Some inherent properties of CPC are directly linked to the product anodes and may not get affected by the process adaptions.

3. Quality Aspects of CPC Affecting Anode Quality

Most of the CPC properties have a direct impact on anode quality and anode performance in the electrolysis process. Their impact on anode quality/performance is shown in Table 2.

Table 2. Quality aspects of CPC and their impact on anode quality.

Sl. No	**Parameters**	**Range**	**Anode quality/ performance**
1	Apparent Density (Hg), g/cm^3	1.7-1.8	Directly related to baked anode density. Anode cycle is decided based on the baked anode density.
2	Real Density, g/cm^3	2.05-2.08	It indicates the calcination level of CPC and baking level in anode making is adjusted as per this value.
3	Hard grove grindability Index (HGI)	33-42	It indicates the hardness of coke and ease with which fines are produced by ball mill.
4	Particle Size (+4.75 mm-0.30 mm), %	30-40	It affects the level of dry aggregate fractions in proportioning system. Density of anodes also gets affected.
6	% Sulphur (S)	0.5-3.00	It affects the CO_2 reactivity of anodes and baking level is adjusted if 'S' content is high to minimise desulphurisation.
8	% Iron (Fe)	0.010-0.060	Fe content in aluminium metal is affected
9	% Silicon (Si)	0.010-0.040	Si content in aluminium metal is affected
10	% Vanadium (V)	0.002-0.025	It affects the air reactivity of anodes.
11	% Nickel (Ni)	0.002-0.025	It affects the air reactivity of anodes.
12	% Sodium (Na)	0.005-0.030	It affects the air & CO_2 reactivity of anodes
13	% Calcium (Ca)	0.005-0.020	It affects the CO_2 reactivity of anodes.
14	Air reactivity %/min	0.05-0.15	It affects the air reactivity of anodes
15	% CO_2 reactivity	10-24	It affects the CO_2 reactivity of anodes

4. Changes in CPC Quality and their Impact on Anode Quality

Coke apparent densities are decreasing over the years. Coke apparent density are dependent on both crude type and coker operation. The preferred coke for anode making is sponge coke. However, shot cokes having isotropic structure and high coefficient of thermal expansion are now a days blended to lower the cost of coke. If present in large percentages anodes may experience cracking problems and mechanical poperies will go down.

The trend of increasing vanadium, nickel and sulphur and other impurity levels is the most problematic issue facing the industry today. Vanadium and Nickel occur as trace organometallic impurities in crude oil and are soluble in crude oil which cannot be separated after processing. These impurities are undesirable as these directly affect the metal purity. Usually, the high Sulphur cokes are associated with presence of high values of Vanadium which is a catalyst for reaction of carbon anodes with oxygen at elevated temperatures. Increased air burn means excess anode consumption and cell performance disturbance. Increased Vanadium also affects the conductivity of EC Wire rods produced in smelter cast houses. Calcium, silicon, sodium and iron are also undesirable impurities in CPC. Increased calcium in CPC can have significant negative affect on CO_2 reactivity of coke and anodes.

Average sulphur levels in CPC are rising. The rise has been from (1.2-2) % to above 3 % level. Today cokes with sulphur levels of (4.5-5.5) % are routinely used for blending by the calcining industry in place of 3.5 % sulphur cokes used previously. Higher sulphur content represent an environmental problem for smelters and calcining industry. This also leads to higher coke consumption. Quality changes observed in CPC and their impact on anode quality is given in Table 3.

Table 3. Changes in CPC quality and their impact on anode quality and smelter performance.

Quality changes in CPC	Impact on anode quality and smelter performance
Decrease in coke density due to crude changes and higher volatile matters.	Anode density will decrease, and anode life will be reduced
Cokes with more isotropic structure will be used (shot cokes)	Increased anode consumption due to increased air and CO_2 reactivity. Risk of anode cracking will increase.
Increased impurity levels particularly Vanadium	Higher air reactivity of anodes leading to increased net carbon consumption. Metal purity will be affected, and conductivity of wire rods will decrease.
Sulphur levels of high sulphur cokes used in blends will increase.	Decrease in anode quality along with risk of desulphurisation during calcinations and baking of anodes.

5. Variation in Quality of CPC Received by NALCO

NALCO Smelter plant is having two carbon plants with installed capacities to produce around 230 000 t baked anodes per annum. Since the inception of the smelter plant, CPC is sourced from 4-6 suppliers. The CPC being received by NALCO can be broadly categorized into two types as per the apparent density & impurities mainly sulphur and vanadium.

Type 1: Apparent density (1.74 -1.76) g/cm^3, S (0.6-0.8) %, V (0.002-0.006) %
Type 2: Apparent density (1.71-1.73) g/cm^3, S (1.5-3) %, V (0.015-0.025) %

The smelter plant receives around 70 % of its CPC supplies of the Type 2 variety. To understand the impact of properties of CPC on anode quality, two typical CPCs were taken for R& D studies as shown in Table 4.

Table 4. Properties of CPC used for R&D study.

Properties	Unit	CPC1	PC2
Apparent density (Hg)	g/cm^3	1.75	1.718
Real density	g/cm^3	2.07	2.06
Moisture	%	0.02	0.01
Ash	%	0.17	0.30
Fe	%	0.007	0.019
Si	%	0.032	0.022
S	%	0.79	2.6
Ni	%	0.006	0.019
V	%	0.005	0.019
Na	%	0.007	0.012
Ca	%	0.005	0.012
HGI		37	34

Properties	Unit	CPC1	PC2
Size + 4.75 mm	%	37.5	32.5
Size -0.3 mm	%	8.3	6.6
Grain stability	%	74	72
Carboxy reactivity	%	12	21.4
Air reactivity	%/min	0.054	0.14

6. R&D Studies Towards Improvement of Apparent Density of Anodes

6.1 Increasing the Apparent Density of Anodes by Blending

Anode bench scale studies were carried out for both types of cokes shown in Table 4, using R&D Carbon (Switzerland) equipment: anode bench scale plant RDC-161 and pilot anode baking furnace RDC-166. The recipe used in the experiment was Very coarse: 20 %, Coarse: 22 %, Medium: 20 %, Fines: 29 %, other baked: 9 %, Pitch: 14.5 %.

The results of bench scale anodes ACPC1 made from CPC1 & ACPC2 made from CPC2 and anodes ACPC3 were prepared by blending 30 % of CPC1 coke in all fractions of CPC2 coke. ACPC3 anodes have shown improved properties compared to ACPC2 is show in Table 5.

Table 5. Quality of anodes from two types of CPC.

Properties	Unit	ACPC1	ACPC2	ACPC3
Green anode density	g/cm^3	1.65	1.619	1.647
Baked anode density	g/cm^3	1.553	1.525	1.546
Real Density	g/cm^3	2.085	2.080	2.08
Air reactivity Residue	%	90.81	65.65	69
Air reactivity loss	%	8.71	23.05	19.9
Air reactivity dust	%	0.48	11.29	11.1
Carboxy reactivity residue	%	73.25	79.86	81
Carboxy reactivity loss	%	13.98	12.92	11.9
Carboxy reactivity dust	%	12.77	7.22	7.11

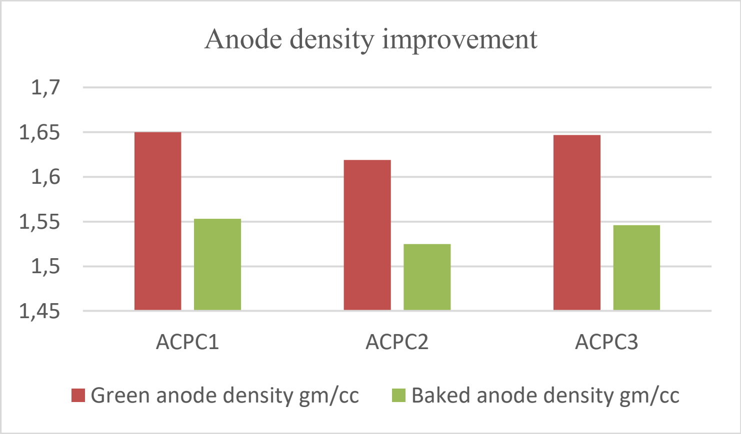

Figure 1. Anode density improvement by blending.

From the above results it is evident that anodes ACPC1 made from high apparent density and low vanadium content show higher green and baked anode density and higher air reactivity residue values whereas anodes made from low apparent density and high vanadium coke show lower green and baked anode density and have lower air reactivity values. The carboxy reactivity values of ACPC2 anodes is better due to high sulphur in CPC2 coke. From the above results it is seen that ACPC3 anodes have higher green and baked density (increase of 0.02 g/cm^3). Air reactivity residue figures for ACPC3 anodes have slightly increased and carboxy reactivity residue values are almost same.

It can be seen that blending of good quality coke with lower quality coke is one of the options for improving the quality of anodes. Proper procurement planning can be made by the industry and good quality coke can be stored in a designated silo and blending may be carried out continuously to achieve the results. Based on the above study improvements in the NALCO CPC specification has been done over the years. NALCO is making efforts for procurement of at least 30 % (of the total CPC requirement) higher density >1.74 g/cm^3 CPC so that blending can be carried out throughout the year. CPC calciners have also been asked to blend their RPC in such a manner so as to achieve uniform better quality of CPC with respect to physical & chemical properties.

6.2 Increasing the Fineness of Fines (Surface Area) to Increase the Apparent Density of Anodes

Anode bench scale experiments carried out with three green anode recipes by varying fineness of fines (surface area as Blaine number) along with decreasing the quantity of fines is shown below in the Table 6.

Table 6. Results of bench scale experiments on effect of fineness of fines on anode density.

Recipe	1	2	3
% Very course	18	18	20
% Course	18	19	22
% Medium	24	25	22
% Fines	29	27	25
% Other baked	11	11	11
% Pitch	14.9	14.9	14.9
% -200 mesh	68	72.5	78
Blaine number	3488	4034	4403
Green anode density g/cm^3	1.61	1.625	1.645
Baked anode density g/cm^3	1.517	1.537	1.547

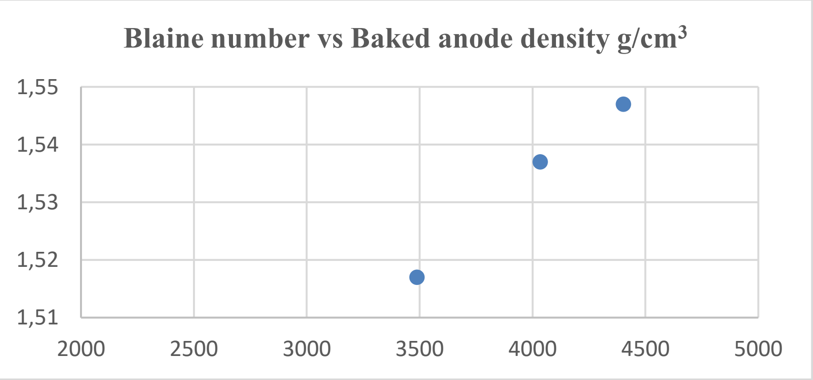

Figure 2. Anode density improvement with Blaine no of fines.

From the above experiment it is found that the green anode density and baked anode density increase with increase in -200 mesh fines and Blaine number. % Fines and % Pitch in the recipe is to be adjusted as per the fineness. With the increase in surface area of fines, the penetration of pitch is better, and the bulk density of fines also increase resulting in better quality anodes. The % fines (-200 mesh) in NALCO green anode plants are being maintained at (80-85) % level compared to the previous values of (70-75) %.

6.3 Increasing the Paste Mixing Temperature to Increase the Apparent Density of Anodes.

Three batches of bench scale anodes were prepared with same pitch and at constant pitch percentage & different mixing temperatures as shown in Table 7.

Table 7. Quality of anodes with increase of mixing temperature of paste.

Sample Identification	**Mixing temp** 147 °C	**Mixing temp** 174 °C	**Mixing temp** 182 °C
Green AD	1.611	1.634	1.644
Baked AD	1.526	1.546	1.559

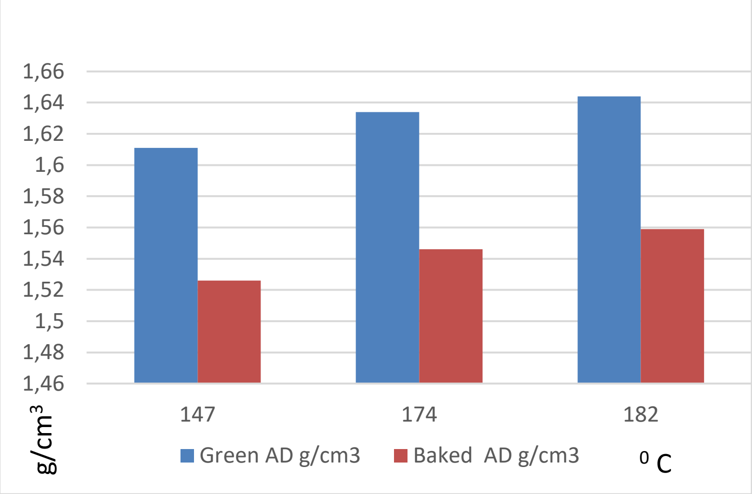

Figure 3. Anode density improvement with paste mixing temperature.

From the above experiment it is found that the green anode density and baked anode density increase with increase in mixing temperature of anode paste. The experiments were carried out at constant pitch percentage. Hence further optimisation of recipe in plant may be required for getting the desired results. The temperature of mixing is normally kept 60 °C higher than the softening point of pitch. Normally the softening point of pitch varies in between (110-115) °C. Hence if the paste mixing temperature is kept above 170 °C, the mixing is better due to better penetration of pitch inside the coke particles and not just on the surface. If the mixer is designed for higher temperature mixing, CT Pitch with high softening point can also be used. Using pitch with high softening point at higher mixing temperature can help in producing better density anodes. At NALCO there are two green anode paste plants; GAP1 operating at mixing temperatures 147 °C & GAP2 operating at 180 °C. As evident the green anodes from GAP1 plant remain lower by 0.02 g/cm^3 if the same coke is used in both the plants.

7. R&D Studies Towards Improvement of Reactivity Properties of Anodes

7.1 Interchanging the Fines Fraction of Two Types of CPC

Anode bench scale studies were carried out to find out the effect of replacing the fines fraction of recipe by fines produced from good quality CPC.

ACPC4 anodes using the fines produced from high grade coke in fines fraction of recipe have better properties than ACPC2 anodes made from CPC2 coke. Air reactivity residue has increased from 65.65 % to 85.44 %, carboxy reactivity residue has increased from 79.86 % to 83.94 %. As shown in Table 8.

Table 8. Quality of anodes made by interchanging of fines fraction.

Properties	**Unit**	**ACPC4**
Green anode density	g/cm^3	1.625
Baked anode density	g/cm^3	1.535
Real density	g/cm^3	2.072
Air reactivity Residue	%	85.44
Air reactivity loss	%	12.89
Air reactivity dust	%	1.67
Carboxy reactivity residue	%	83.94
Carboxy reactivity loss	%	9.56
Carboxy reactivity dust	%	6.5

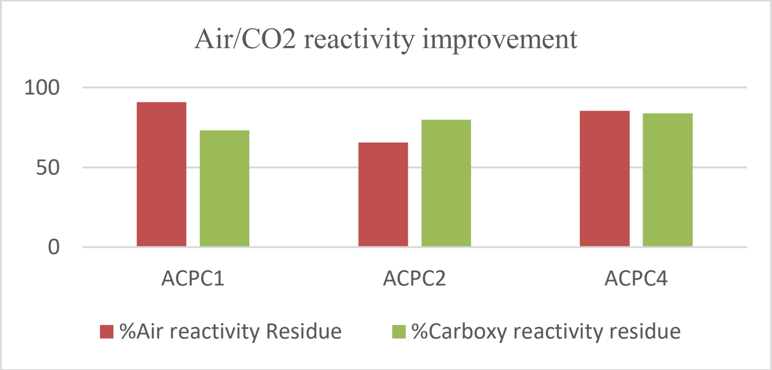

Figure 4. Air/CO$_2$ reactivity improvement with use of fines of higher-grade coke.

The anodes made from using fines of better-quality coke show improvement in apparent density as well as the reactivity figures of anodes of due to low impurity level of fines. Depending on the availability of CPC the carbon plant unit operation flow sheet can be modified to accommodate a separate bin in the circuit for storing only the ball mill fines fraction of good quality CPC for blending.

7.2 Boric Acid Addition in Green Anode Recipe

A paper was published on R&D trial on improvement in oxidation behaviour of anodes in ICSOBA 2017 [4] [9]. Based on the success of one-year actual trial in the plant, regular addition of boric acid is carried out in two green anode plants of NALCO.

Improvement observed in NALCO anode quality due to regular addition of (0.1-0.20) % boric acid in the green anode plant is presented in the Table 9.

Table 9. Results of regular addition of boric acid in green anode plants to improve Air Reactivity residue of anodes.

	No addition of boric acid (Dec. 2017-March 2018)	**With addition of boric acid (Dec 2018-March 2019)**
Boric acid/T green anodes produced		1.175
Avg % Air Reactivity Residue (ARR)	68	83
Avg Metal purity (% Al)	>99.7	>99.7

Due to the above improvement in Air reactivity residue of anodes, the net carbon reduction observed was 3.7 kg/t of Al metal. This is equivalent to reduction in CO_2 emission by around 13.6 kg/t Al metal. Cost wise the savings would be approx. 42.5 million/annum for NALCO plant producing 0.46 Mt metal per annum. It was also observed that there was significant decrease in number of fallen anodes, half fallen anodes and other anodic incidences in potline.

From the above data it is observed that by addition of 0.12 % boric acid in green anode recipe, the air reactivity residue of carbon anodes shows significant improvement.

7.3 Boric Acid Addition in CPC at Coke Calcining Plant

Boric acid powder was added to the calcined CPC at the discharge end of the calcining process (out of the cooler) when the temperature of the bulk material was between (140– 160) °C [10]. 2 kg boric acid was thoroughly mixed manually with one tonne hot CPC. CPC samples collected was tested before and after doping with boric acid. Table 10 shows the test results of CPC3 (without doping) and CPC4 (with doping).

Table 10. Test results of CPC without and with doping of boric acid.

Properties	**Unit**	**CPC3**	**CPC4**
Apparent density (Hg)	g/cm^3	1.72	1.72
Real Density	g/cm^3	2.065	2.065
Fe	%	0.020	0.020
Si	%	0.019	0.019
S	%	2.15	2.14
Ni	%	0.018	0.018
V	%	0.024	0.024
Na	%	0.008	0.008
Ca	%	0.009	0.010
CO_2 reactivity	%	13	0.8
Air reactivity	%/min	0.41	0.04

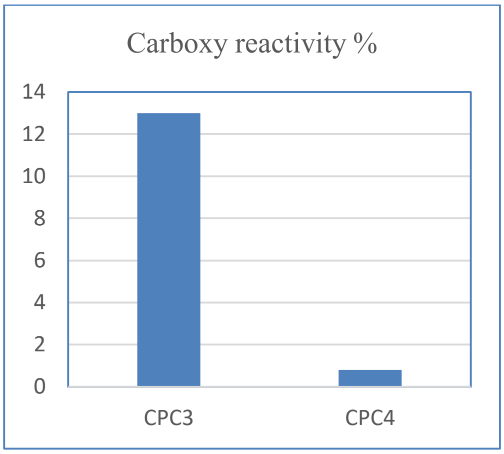

Figure 5. Decrease in CO_2 reactivity of CPC doped with boric acid.

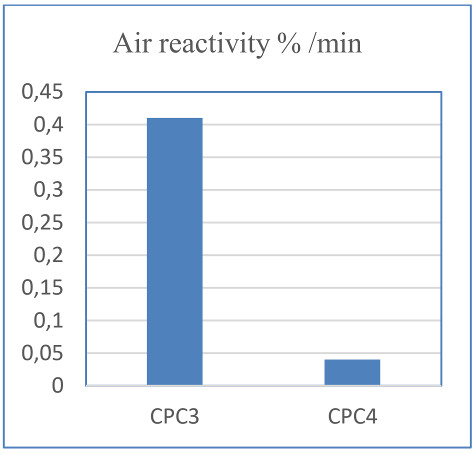

Figure 6. Decrease in air reactivity of CPC doped with boric acid.

Bench scale anodes ACPC5 & ACPC6 were also fabricated from CPC3 & CPC 4 which show improvement in Air and CO_2 reactivity residue values of anodes made from CPC doped with boric acid, as shown in Table 11.

Table 11. Test results of anodes made from with and without doped CPC.

Properties	Unit	ACPC5	ACPC6
Green anode density	g/cm^3	1.621	1.629
Baked anode density	g/cm^3	1.535	1.545
Real density	g/cm^3	2.078	2.084
Air reactivity Residue	%	80.5	91.2
Air reactivity loss	%	15.8	8.37
Air reactivity dust	%	3.70	0.43
Carboxy reactivity residue	%	73.5	86.0
Carboxy reactivity loss	%	8.9	9.3
Carboxy reactivity dust	%	17.6	4.7

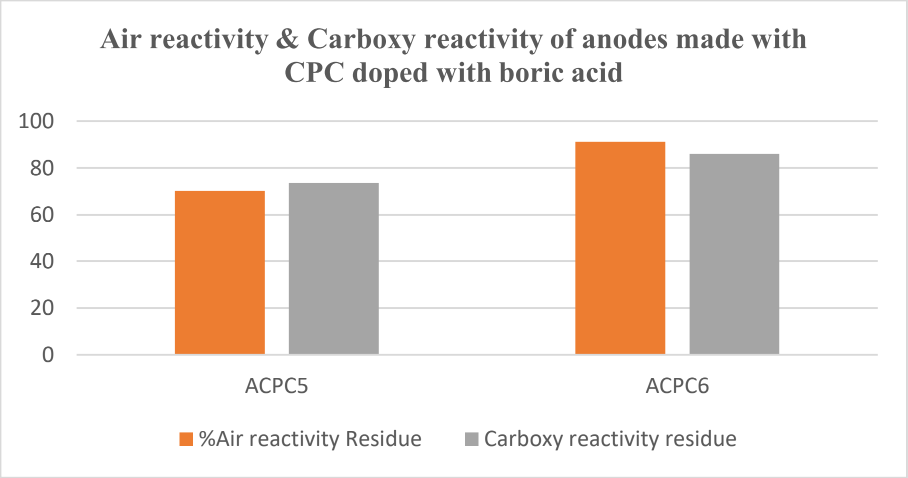

Figure 7. Improvement in Air and CO_2 reactivity of anodes using CPC doped with boric acid.

From the above experiment it could be observed that by using boric acid doped CPC for making anodes, the CO_2 and Air reactivity residue of anodes improve significantly. This solution can be adapted by coke calciners in consultation with aluminium smelters. A measured quantity of boric acid can be added at calciner by making special arrangements, to produce low reactive CPC. Boron limit can be given in the specification of CPC by the smelters.

8. Dealing with High Sulphur Cokes

Sulphur levels may continue to rise due to practises of blending of fuel grade coke with anode grade cokes at the coking/calciner's operations for lowering the cost. In order to meet environmental norms, SO_2 scrubbing may be adopted more widely in the future by calciners and smelters. Desulphurisation during anode baking needs to be checked by maintaining baking homogeneity in anodes and avoiding excessive high anode baking temperatures.

At present sulphur level of CPC used by NALCO remains below 3 %. It is observed that when % S in few CPC supplies is > 2.5 %, the CO_2 reactivity of anodes made from such cokes is significantly higher than the CO_2 reactivity of anodes made from CPC with S < 1.5 %.

9. Summary and Conclusions

In this paper, the aluminium industry's experience in dealing with the impact of utilising calcined petroleum coke with lower density and higher impurities on anode quality in the recent years has been described. It has been shown [5] that blending of cokes at calciners and smelters will remain the dominant strategy to deal with the issue of quality changes. Impact of blending of CPC of different qualities, impact of blending only the fines fraction of CPC having lower impurities, impact of process parameters i.e. paste mixing temperature and Blaine number on anode quality have been presented in the paper.

Increase in Sulphur, Vanadium & Nickel in CPC will remain the most obvious quality changes in future. To deal with the issues of reactivity of anodes i.e. higher air reactivity losses due to high vanadium CPC it is suggested to add boric acid in controlled manner without affecting the metal purity. This methodology has been adapted by NALCO. The results of plant data are shown in this paper. It has also been experimented that if CPC is pre-treated with boric acid at any suitable point in the calcining process, the anodes made out of such cokes have superior Air & CO_2 reactivity values.

The R&D studies presented in this paper may become useful for Aluminium Industries to address the problem of density and reactivity properties of anodes which may arise due to non-availability of suitable grade CPC at present and also in future. However, the role of calcining industry in supplying good quality CPC also remain significant.

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