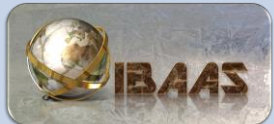


IBAAS 2026

TECHNICAL LECTURE SERIES

**IMPACT OF QUALITY CHANGES IN
CALCINED PETROLEUM COKE
(CPC) ON ANODES USED IN
ALUMINIUM PRODUCTION**



BINUTA PATRA

Presenter's Bio

Name: **Binuta Patra**

Former position: **Group General Manager (R&D), NALCO**

Qualifications: **B.Sc. Engg. (Chemical), 1985**

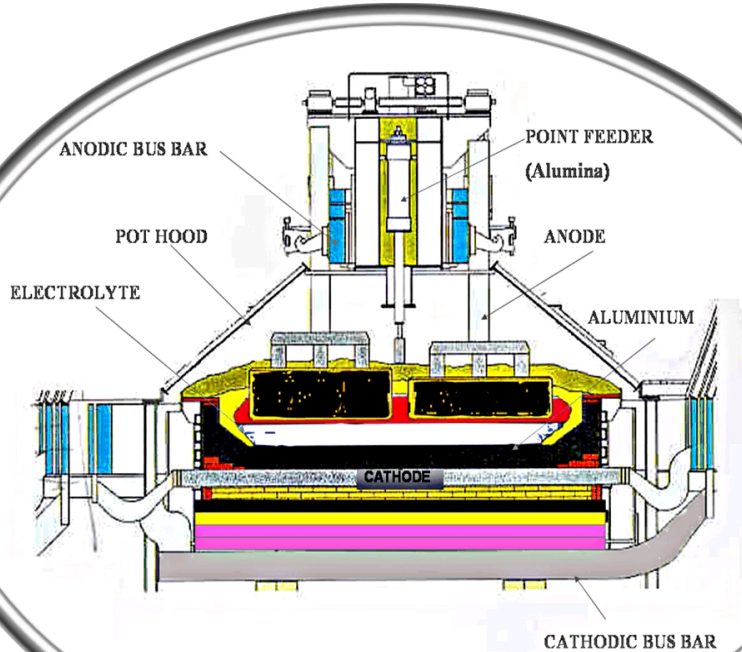
M.Tech. (Environmental Science & Engineering), 2013

Experience: **38 years in the Aluminium Industry**

Plan of Presentation

- **Introduction – Hall–Hérault Process**
- **Calcined Petroleum Coke (CPC) – Manufacturing Process**
- **Role of CPC in making of Prebaked Anodes**
- **Quality Aspects of CPC Affecting Anode Performance**
- **Indian Scenario – Challenges in CPC Availability**
- **Strategies for Improving Anode Quality**
- **Conclusions**

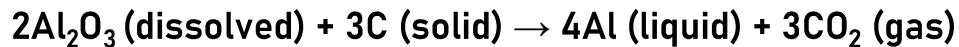
Introduction



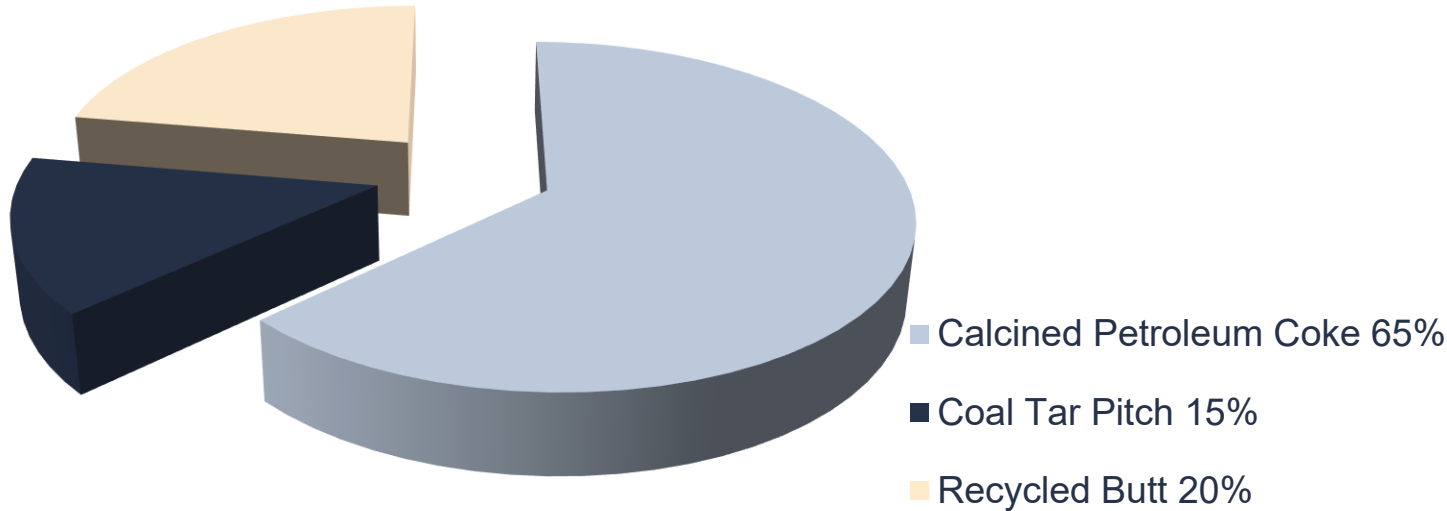
Aluminium is produced through the Hall-Héroult process, where alumina is electrolytically reduced in molten cryolite.

During this process, Oxygen is released at the carbon anode and reacts with carbon to form carbon dioxide, while molten aluminium is deposited at the cathode.

The carbon anode plays a dual role – it acts as a current conductor and is continuously consumed during electrolysis.

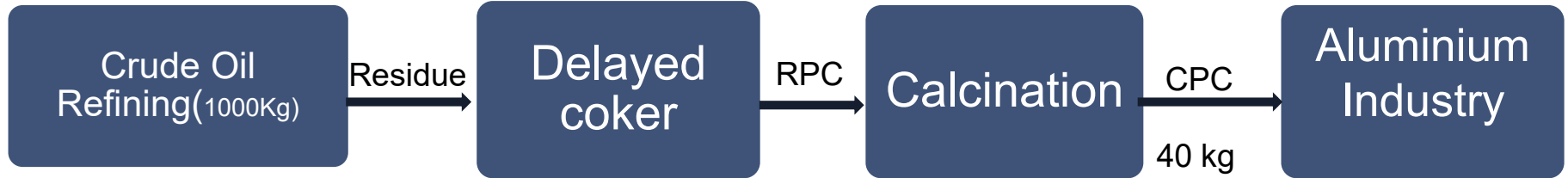


Raw materials for Prebaked Anodes



- **Calcined Petroleum coke or CPC is the most important raw material in anode production , contributing nearly 65% of the composition.**
- **Properties of CPC directly influence anode quality and ultimately smelter performance**
- **However in recent years CPC quality has been changing due to increased use of lower cost high sulphur crude and growing demand for Aluminium**

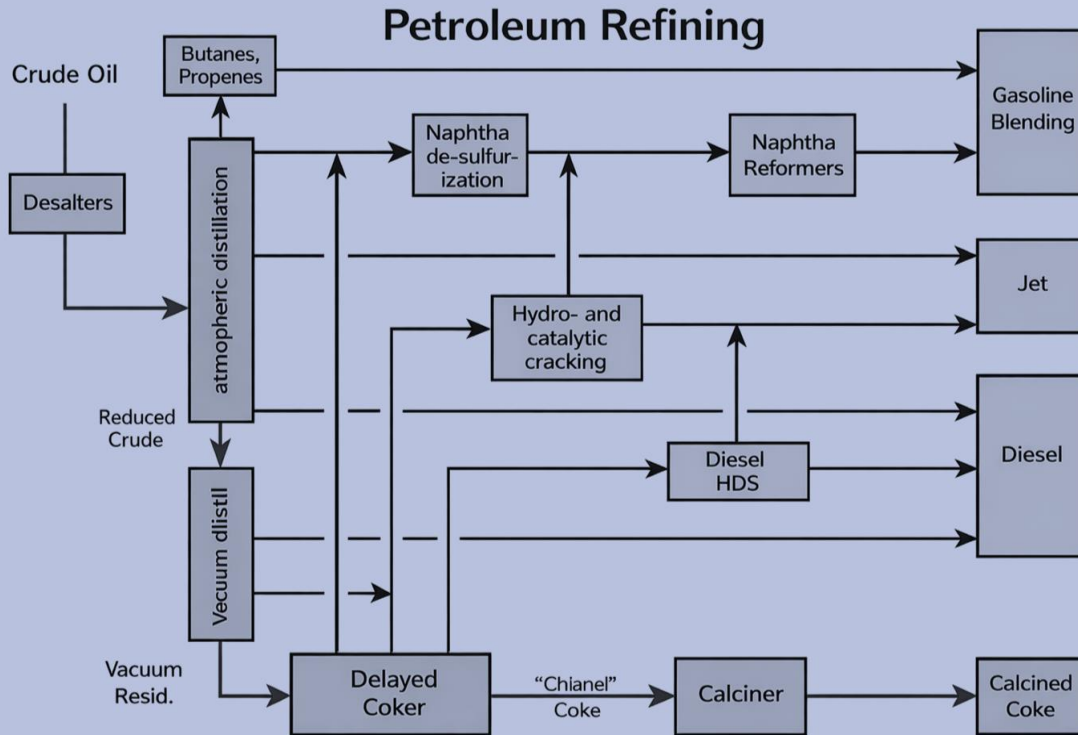
Calcined Petroleum Coke's journey from Petroleum Refinery to Aluminium Industry



The quality of calcined petroleum coke is affected by

- *Choice of crude, initial refinery process steps*
- *Coking and Calcining processes*
- *Handling systems between the refinery, calciner and final customer*

From Crude Oil to Raw Petroleum Coke (RPC)



Crude oil undergoes:

Atmospheric/vacuum distillation & catalytical processing to produce

Light straight run gasoline 11%

Reformer Naphtha 25%

Kerosine 15%

Diesel Fuel 10%

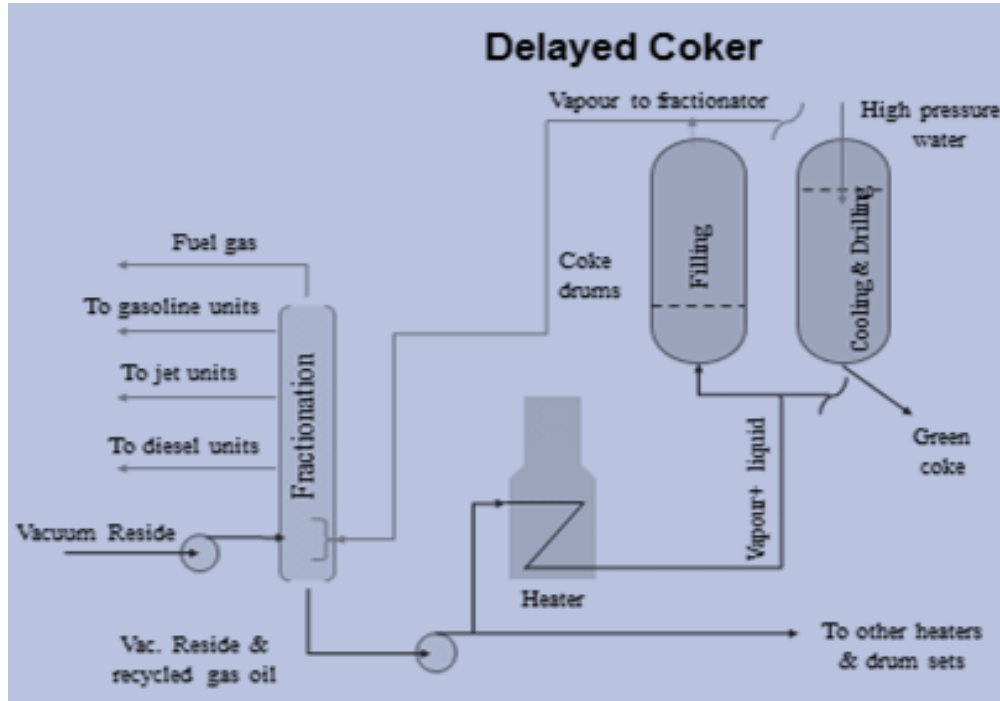
Gas oil 31%

Residue 8% - COKER FEEDSTOCK

Chemical properties of RPC such as Sulphur & metals are directly related to Crude oil quality

Delayed Coker

- Convert low-value residual oils into higher-value lighter products.
- Final carbonization occurs in coke drums at high temperature and pressure



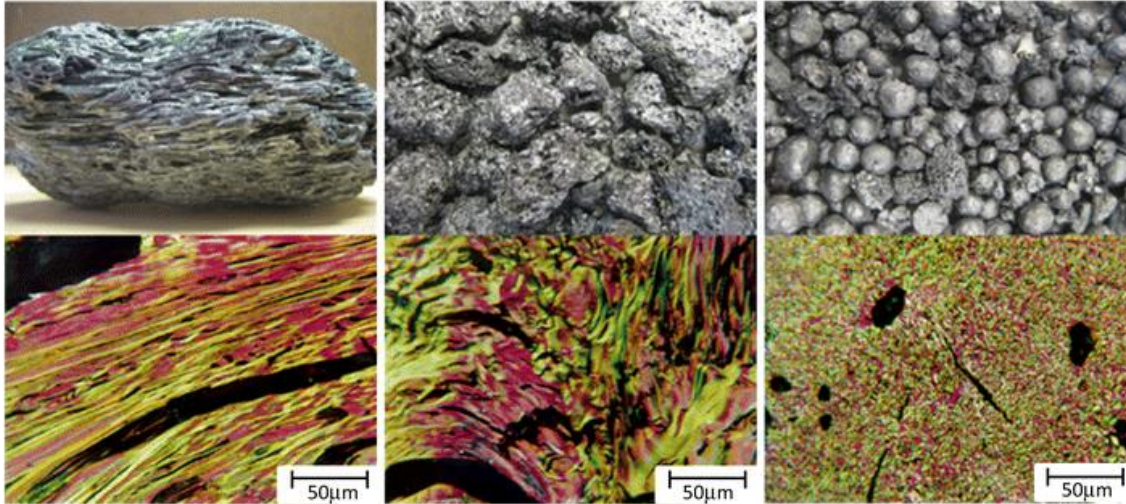
Physical properties of RPC such as volatile matter & moisture are related to the operating variable of delayed coker

Delayed coke types and optical textures

Shot Coke-Spherical shape, High CTE, Shiny exterior

Sponge Coke (Anode Grade)-Well-developed pore structure, Lower CTE, Preferred for aluminium anodes

Needle Coke (Used in graphite electrode manufacturing)-Needle-like structure, Lowest CTE, Low metals and sulphur

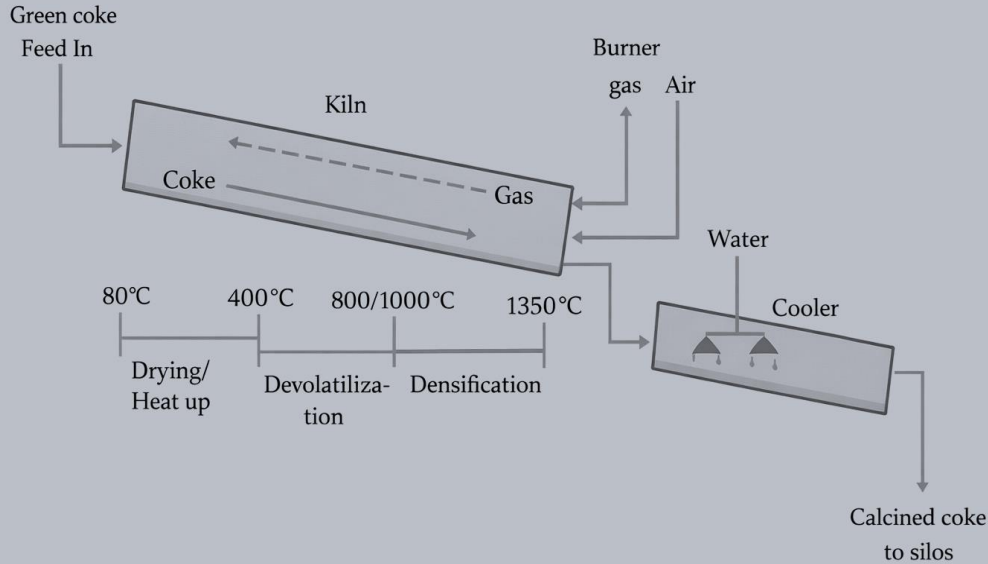


Needle
Anisotropic

Sponge
Mixed

Shot
Isotropic

Calcination: RPC to CPC



Calcination is a thermal treatment (~1250°C) that:

Removes moisture and volatile matter

- Increases electrical conductivity
- Improves real density
- Enhances oxidation resistance

Calcination Methods:

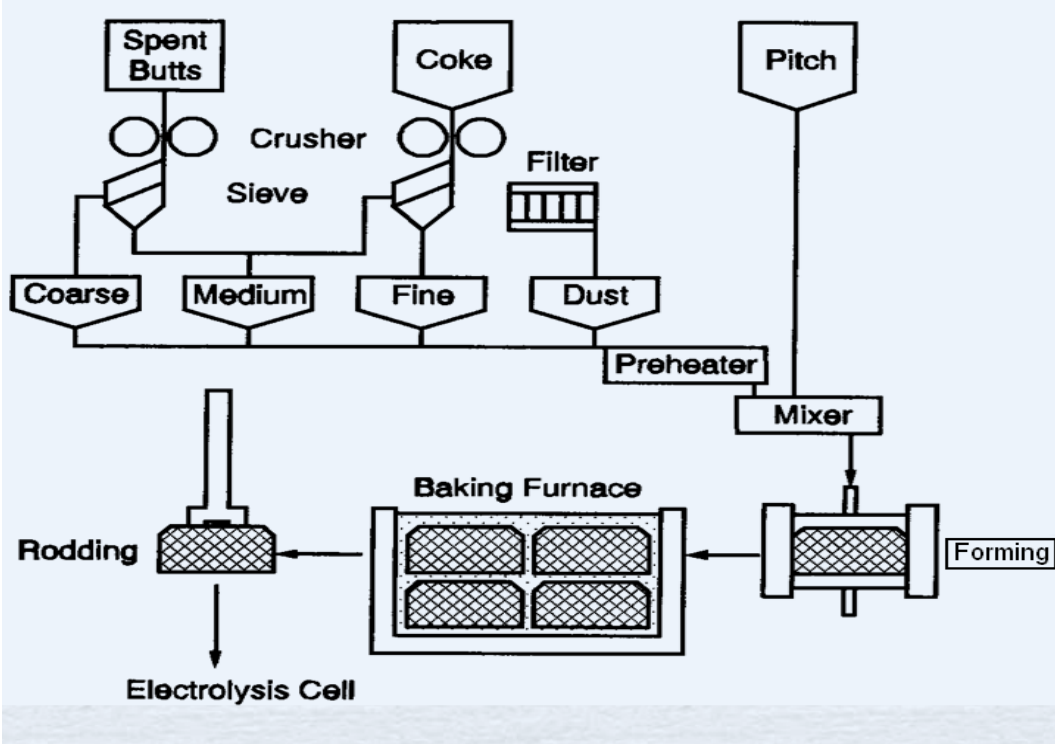
- Rotary kiln (most widely used)
- Rotary hearth furnace
- Vertical shaft kiln

The calcining operation has a significant influence on CP coke quality. Cokes with substantially different volatile contents (in both quality and quantity) and impurity levels should be calcined under different conditions.”

Typical analysis of RPC and CPC

| PARAMETER | UNITS | RPC | CPC |
|------------------|--------|-------------|-------------|
| Mositure | % | 10.0 | 0.20 |
| Volatile Matter | % | 10 - 15 | 0.50 |
| Ash | % | 0.2 - 0.5 | 0.50 |
| Fixed Carbon | % | 70 - 80 | 99.0 |
| Sulphur | % | 0.5 - 4.0 | 1.0 - 3.0 |
| Iron | ppm | 100 - 500 | 300 - 500 |
| Silicon | ppm | 100 - 500 | 300 - 500 |
| Nickel | ppm | 100 - 300 | 100 - 300 |
| Vanadium | ppm | 100 - 500 | 100 - 300 |
| Real Density | gms/cc | 1.4 - 1.6 | 2.0 - 2.1 |
| Bulk Density | gms/cc | 0.60 - 0.70 | 0.8 - 0.9 |
| H. G. I | | 80 - 120 | 35 - 45 |
| Apparent Density | | 1.3 - 1.4 | 1.70 - 1.75 |

C P coke to anodes



Carbon Plant

Green anode plant



Baking Furnace



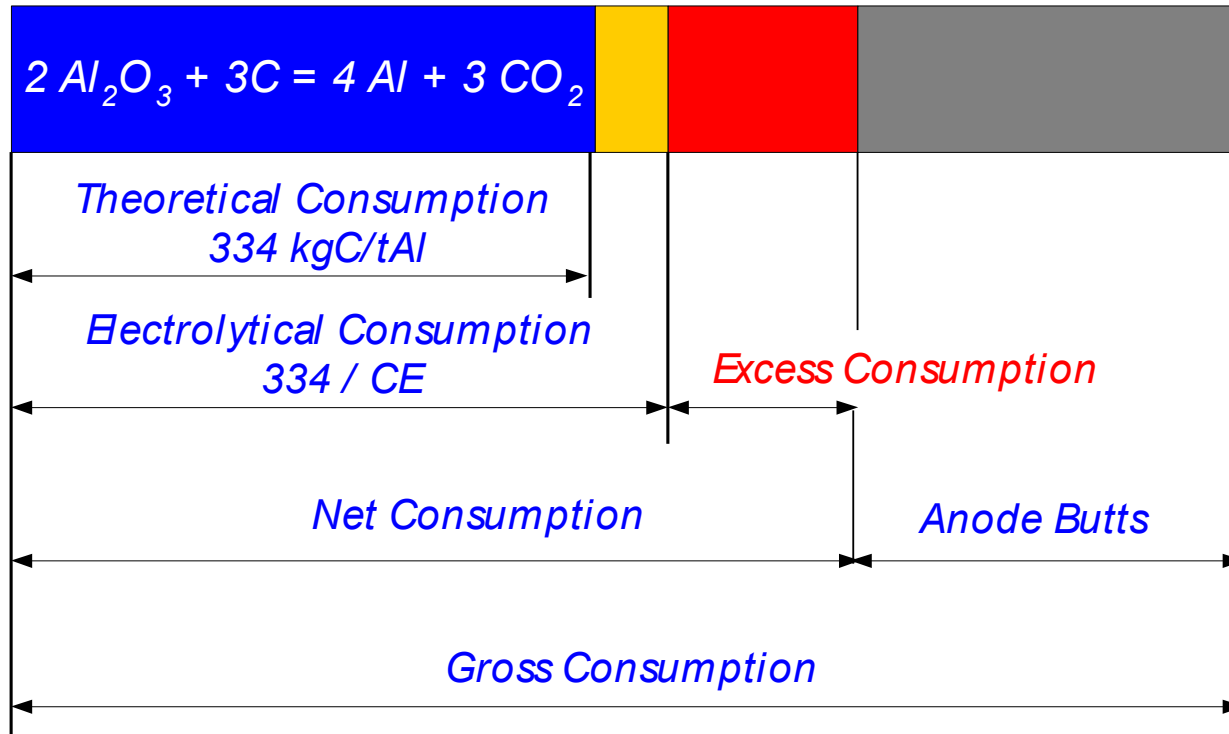
Rodding Plant



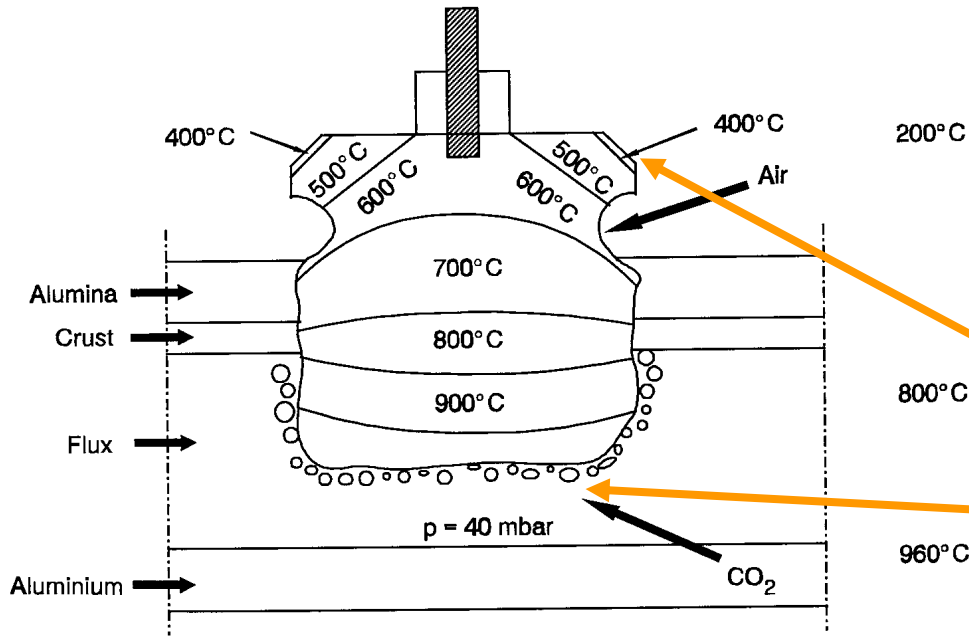
Anode Consumption Mechanism

Modern smelters require anodes of highest quality in order to reach a

- Gross Consumption of 560 kg C/t Al.
- Net Consumption of 410 kg C/t Al.



Anode Consumption Mechanism



Electrochemical Formation CO₂
 $\text{Al}_2\text{O}_3 + 3\text{C} = 4\text{Al} + 3\text{CO}_2$

Electrochemical Formation CO
 $2\text{Al} + 3\text{CO}_2 = \text{Al}_2\text{O}_3 + 3\text{CO}$

Reaction O₂ with Anode
 $\text{O}_2 + \text{C} = \text{CO}_2$ (Air Reactivity)

Back Reaction CO₂ with Anode
 $\text{CO}_2 + \text{C} = 2\text{CO}$ (CO₂ Reactivity)

Preferential Oxidation binder (Dusting)

Critical Properties for Prebaked Anodes

- **High apparent density**
- **High mechanical strength**
- **Low electrical resistivity**
- **High thermal shock resistance**
- **Low chemical reactivity**
- **High chemical purity**

Properties of Baked Anodes

| <i>Property</i> | <i>Unit</i> | <i>Method</i> | <i>Typical Range</i> |
|------------------------------------|---------------------|---------------|----------------------|
| Apparent Density | kg/dm ³ | ISO N 838 | 1.50 - 1.60 |
| Spec. Electric Resistance | mΩm | ISO N 752 | 50 - 60 |
| Flexural Strength | MPa | ISO N 848 | 8 - 14 |
| Compressive Strength | MPa | Din 51910 | 40 - 55 |
| Coefficient thermal expansion | 10 ⁻⁶ /K | | 3.5 - 5.5 |
| Fracture energy | J/m ² | | 250 - 350 |
| Thermal Conductivity | WmK | | 3.0 - 4.5 |
| Density in Xylene | kg/dm ³ | ISO DIS 9088 | 2.05 - 2.10 |
| Air permeability | nPm | | 0.5 - 2.0 |
| CO ₂ Reactivity residue | % | ISO N 804 | 84 - 95 |
| CO ₂ Reactivity loss | % | | 1 - 10 |
| Air reactivity residue | % | ISO N 805 | 65 - 90 |
| Air reactivity loss | % | | 2 - 10 |

| <i>Elements</i> | <i>Unit</i> | <i>Typical Range</i> |
|-----------------|-------------|----------------------|
| S | % | 0.5 - 3.2 |
| V | ppm | 30 - 320 |
| Ni | ppm | 40 - 200 |
| Si | ppm | 50 - 300 |
| Fe | ppm | 100 - 500 |
| Na | ppm | 150 - 600 |
| Ca | ppm | 50 - 250 |
| Mg | ppm | 10 - 50 |
| F | ppm | 150 - 600 |
| Zn | ppm | 10 - 50 |
| Pb | ppm | 10 - 50 |

Anode behaviour in Hall Heroult Cell

In 1991, Fischer et al. published the following formula, based on 20 years of practical experience, for the prediction of net carbon:

$$NC = C + \frac{334}{CE} + 1.2 (BT - 960) - 1.7 CRR + 9.3 AP + 8 TC - 1.5 ARR$$

| | | | |
|-----|-----------|------------------------------------|-------------|
| NC | [kgC/tAl] | Carbon net consumption | 400 - 500 |
| C | [-] | Cell factor | 270 - 310 |
| CE | [%] | Current efficiency | 0.82 - 0.95 |
| BT | [°C] | Bath temperature | 945 - 980 |
| CRR | [%] | CO ₂ reactivity residue | 75 - 90 |
| AP | [nPm] | Air permeability | 0.5 - 5.0 |
| TC | [W/mK] | Thermal conductivity | 3.0 - 6.0 |
| ARR | [%] | Air reactivity residue | 60 - 90 |

Quality aspects of CPC and their impact on Anode quality

| Parameters | Typical Range | Anode quality/ performance |
|---|----------------|---|
| Apparent Density(Hg), g/cm ³ | 1.70 – 1.75 | Pitch demand, green density, baked density,.Anode cycle is decided based on the baked anode density. |
| 28x48 mesh VBDg/cm ³ | 0.84 – 0.89 | do |
| Real Density, g/cm ³ | 2.04-2.08 | It indicates the calcination level of CPC and baking level in anode making is adjusted. |
| % Sulphur (S) | 0.5 – 3.0 | It affects the net carbon consumption,Air/CO ₂ reactivity of anodes and baking levels adjusted for desulphurisation. Environmental impact. |
| Iron (Fe), | 50 – 400 ppm | Metal contamination |
| Silicon(Si) | 50-200ppm | Metal contamination |
| Vanadium(V) | 50 – 300 ppm | It affects the air reactivity of anodes along with purity of metal |
| Nickel (Ni) | 50-200ppm | Metal contamination |
| Sodium(Na) | < 150 ppm | It affects the air & CO ₂ reactivity of anodes thus net carbon consumption |
| Calcium(Ca) | < 150 ppm | It affects the CO ₂ reactivity of anodes thus net carbon consumption |
| Air reactivity %/min | 0.1 - 0.7%/min | It affects the air reactivity of anodes thus net carbon consumption |
| % CO ₂ reactivity | 5 – 20% | It affects the CO ₂ reactivity of anodes thus net carbon consumption |
| Grain Stability | 75 – 85% | Minimise particle degradation during mixing, flexural strength of anodes |
| +4 mesh particle size | 30 – 50% | Anode aggregate formulation |

Why and How is Coke Quality Changing?

- **Refineries on average are running more lower cost, higher sulfur and heavier crudes (sour crudes) which directly impact coke quality.**
- **The significant increase in aluminium production and demand for coke is not being matched by growth in traditional quality anode grade cokes.**

Aluminium Capacity in India:

- Current: ~4.1 million tons
- Projected: ~8 million tons

CPC Requirement:

- Current: ~1.3 million tons
- Projected: ~2.6 million tons

Challenges:

- Limited availability of low-sulphur RPC ($\leq 1.25\%$)
- Only 5 of 23 refineries produce anode-grade RPC
- Domestic supply gap:
 - 92% (if 1.25% sulphur CPC required)
 - 82% (if 2.5% sulphur CPC accepted)

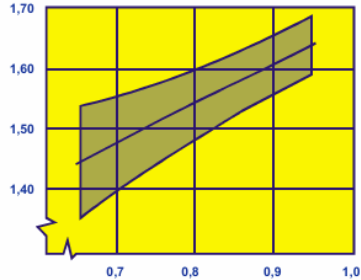
Changes seen in CPC quality and their impact on Anode quality and Smelter performance

| Quality changes in CPC(risks) | 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 may 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. Increased net carbon consumption.Environmental challenges. |

Impact of decrease in **Coke bulk density** on Anode quality

INTERDEPENDENCE BETWEEN THE BULK DENSITY OF COKES AND THE APPARENT DENSITY OF BAKED ANODES

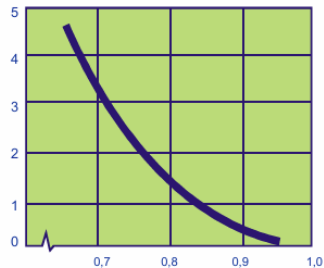
APPARENT DENSITY OF ANODES (Kg / dm³)



BULK DENSITY OF COKES (Kg / dm³)

INTERDEPENDENCE BETWEEN THE BULK DENSITY OF COKES AND THE AIR PERMEABILITY OF ANODES

AIR PERMEABILITY OF ANODES (Kg / dm³)



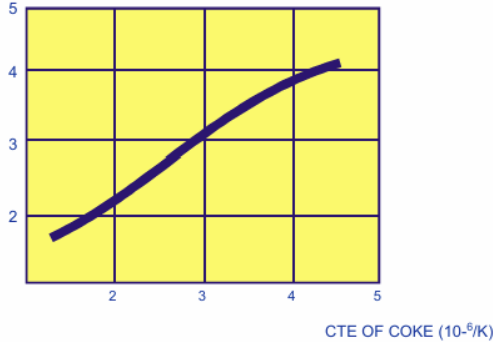
BULK DENSITY OF COKES (Kg / dm³)

- **Decrease in baked anode density**
- **Decreased anode shift life**
- **Increased anode production cost**
- **Air permeability of anodes will increase leading to increased carbon consumption**
- **Specific electrical resistance will increase leading to increased power consumption**

Impact of Isotropic cokes (low CTE) on anode quality

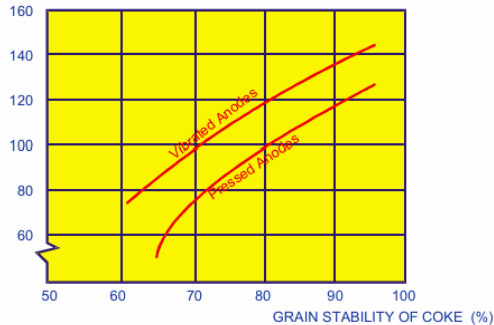
INTERDEPENDENCE BETWEEN THE CTE OF COKE AND THE COEFFICIENT OF THERMAL EXPANSION OF ANODES

COEFFICIENT OF THERMAL EXPANSION OF ANODES ($10^{-6}/K$)



INTERDEPENDENCE BETWEEN THE GRAIN STABILITY OF COKE AND THE FLEXURAL STRENGTH OF VIBRATED AND PRESSED ANODES

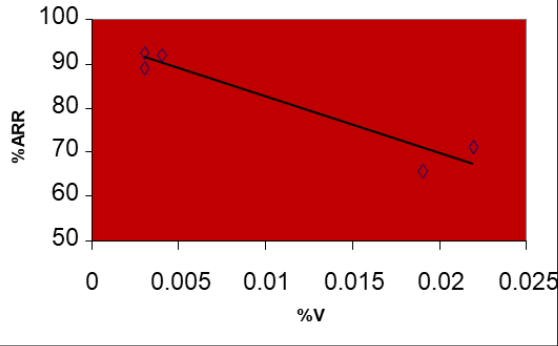
FLEXURAL STRENGTH OF ANODES ($10^5 N/m^2$)



- Presence of shot cokes in CP coke matrix, will lead to production of anodes with higher CTE values and lower flexural strength
- Possibility of development of anode cracks during electrolysis

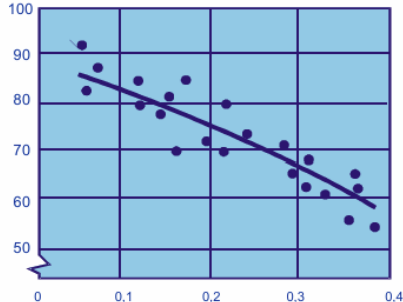
Impact of Increase of Vanadium in CP coke on Anode quality

%Vanadium vs % ARR $R^2 = 0.9116$



INTERDEPENDENCE BETWEEN THE AIR - REACTIVITY OF COKES AND THE AIR - REACTIVITY RESIDUE OF ANODES

AIR - REACTIVITY RESIDUE OF ANODES (%)

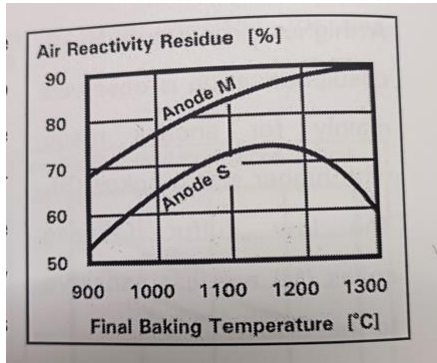
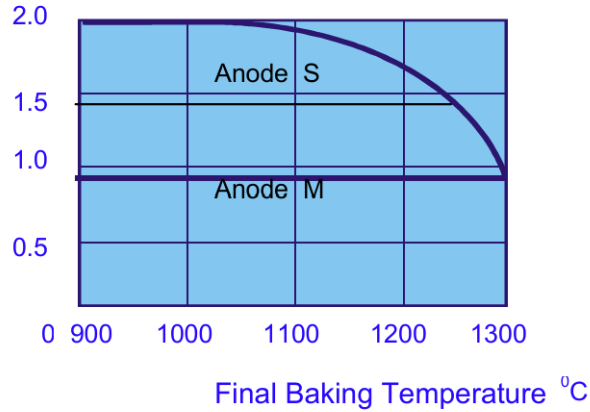


AIR - REACTIVITY OF COKES

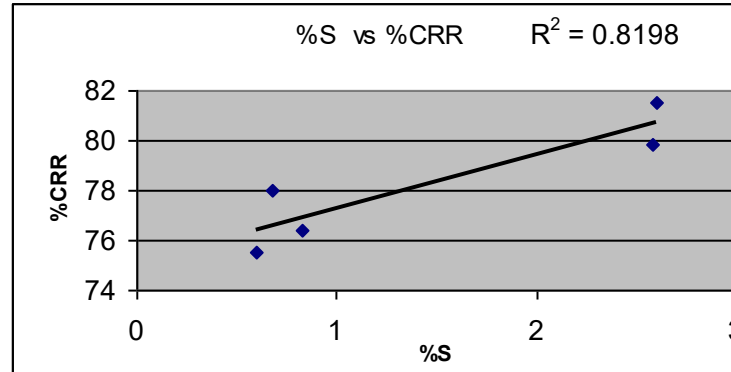
- Increased vanadium in CP coke leads to higher air reactivity in CP coke and lower air reactivity residue in anodes
- Increased net carbon consumption and carbon dusting
- Possibility of iron contamination due to bath flooding in tapdoor end anodes (air ingress)
- Metal contamination

Impact of Increase of Sulphur in CP coke on Anode quality

Sulfur Content (%)



- Increased net carbon consumption due to net loss of Sulphur
- Desulphurisation and increased air reactivity
- CO₂ reactivity residue may increase but effect of recycled S on electrolytic bath and CE need to be assessed
- Environmental challenges.



Impact of Increase of Sulphur in CP coke on Anode quality

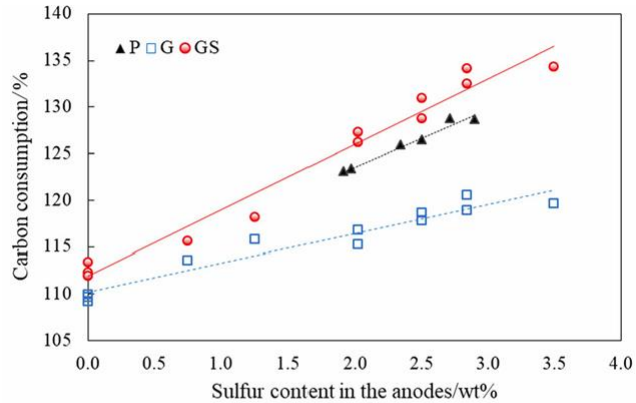


Fig. 7—Carbon consumption (CC) as a function of sulfur content in the anodes ($c(S)_A$). P: series with prebaked anodes, G: series with graphite anodes, GS: series with graphite anodes and added sodium sulfate.

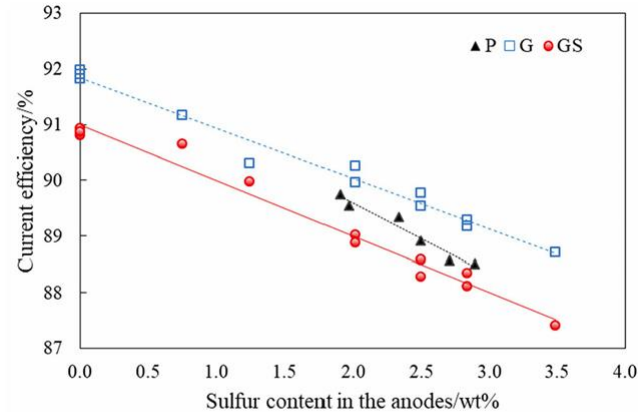


Fig. 2—Current efficiency (CE) as a function of sulfur content in the anodes ($c(S)_A$). P: series with prebaked anodes, G: series with graphite anodes, GS: series with graphite anodes and added sodium sulfate.

Results of lab scale experiment : It was found that CE lowers by 1.3 pct per 1 wt pct S, and CC increases by 6.1 pct per 1 wt pct S for prebaked anodes.

R &D studies towards improvement of anode quality

The studies shown in the following slides were conducted at the Smelter Plant of National Aluminium Company Limited (NALCO), and the results have been published in relevant publications.

Important basic reference data are :

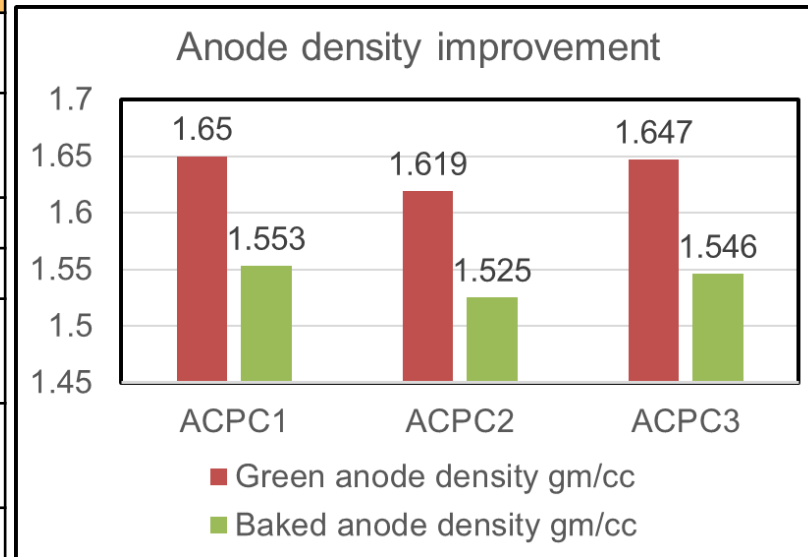
- 180 kA – Aluminium Pechiney AP (now RTA Rio Tinto Alcan) cell technology
- 460 000 tpa capacity (960 pots, 4 potlines 240 cells each)
- Fume treatment plants with dry scrubbing system
- Two carbon plants to manufacture anodes
- Prebaked anode dimensions 1450X1000X550 MM ,Weight 1180 kg
- Integrated facility for manufacturing Aluminium ingots, sows, wire rods, strips, billets, rolled products, T ingots, chequered sheets

Properties of CPC used for R&D study

| Properties | Unit | CPC1 | CPC2 |
|-----------------------|-------------------|-------|-------|
| 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 |
| 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 |

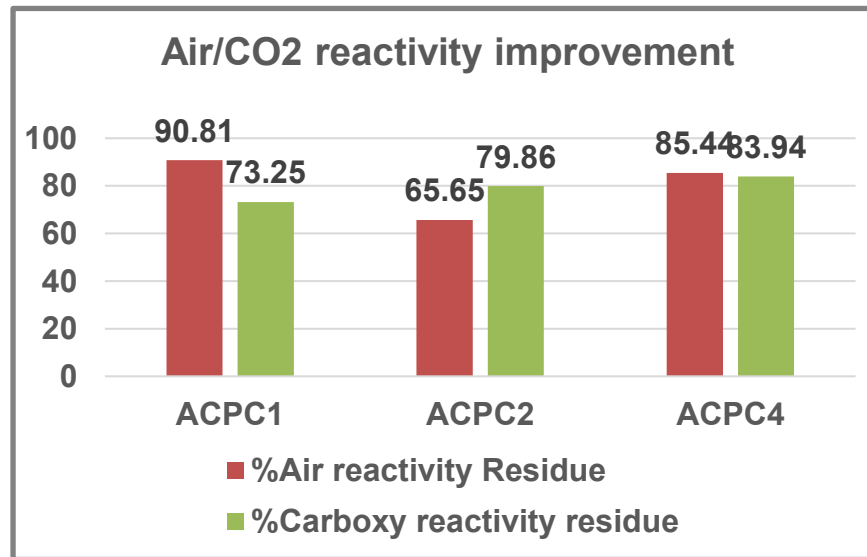
Increasing the apparent density of Anodes by blending

| 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 |



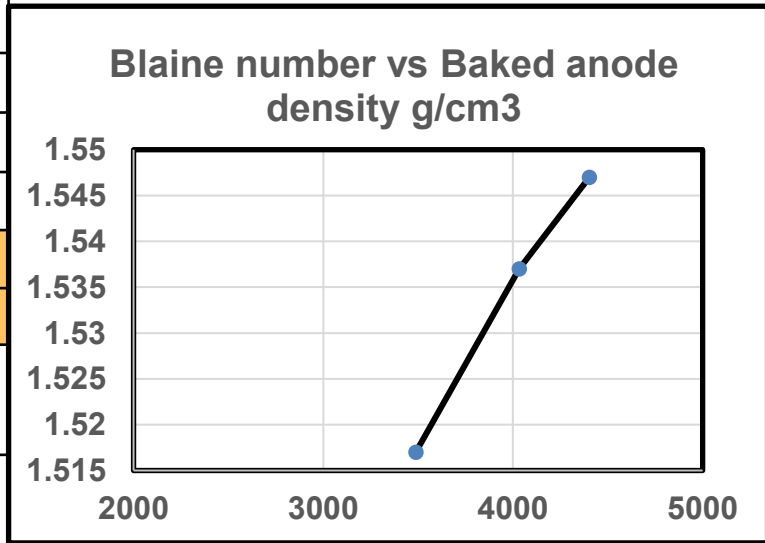
Quality of Anodes made by interchanging of fines fraction

| Properties | Unit | ACPC1 | ACPC2 | ACPC4 |
|----------------------------|-------------------|-------|-------|-------|
| Green anode density | g/cm ³ | 1.65 | 1.619 | 1.625 |
| Baked anode density | g/cm ³ | 1.553 | 1.525 | 1.535 |
| Real density | g/cm ³ | 2.085 | 2.080 | 2.072 |
| Air reactivity Residue | % | 90.81 | 65.65 | 85.44 |
| Air reactivity loss | % | 8.71 | 23.05 | 12.89 |
| Air reactivity dust | % | 0.48 | 11.29 | 1.67 |
| Carboxy reactivity residue | % | 73.25 | 79.86 | 83.94 |
| Carboxy reactivity loss | % | 13.98 | 12.92 | 9.56 |
| Carboxy reactivity dust | % | 12.77 | 7.22 | 6.5 |



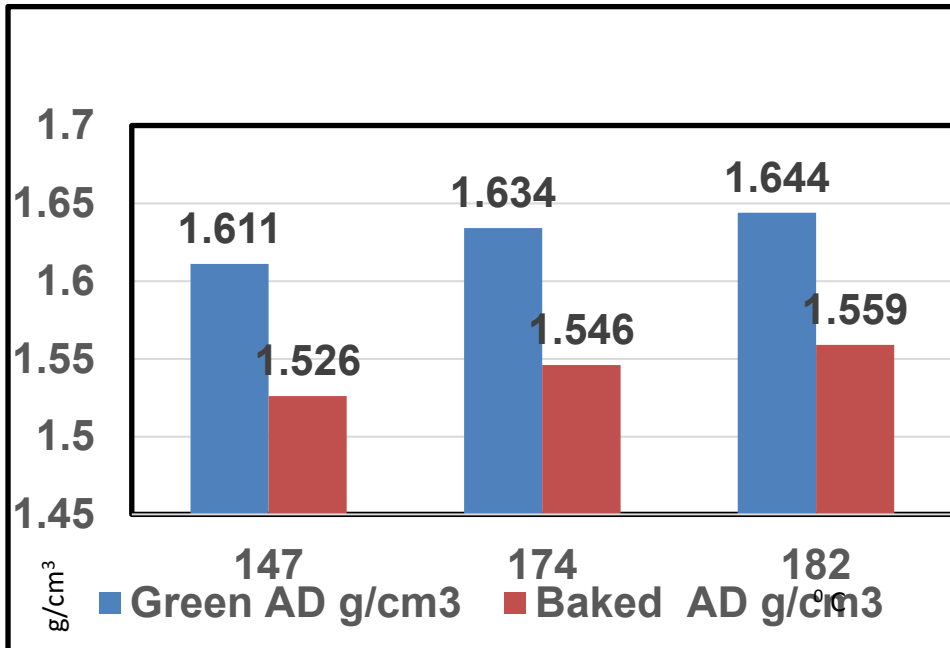
Increasing the fineness of fines (surface area) to increase the apparent density of Anodes

| 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 |

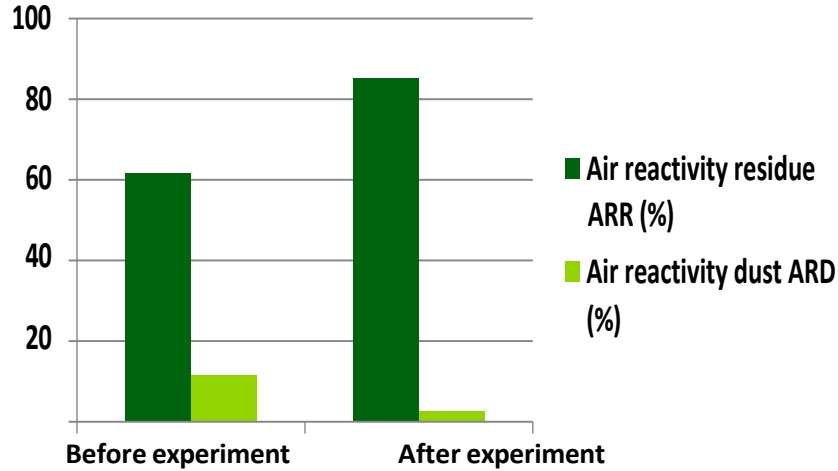


Increasing the paste mixing temperature to increase the apparent density of Anodes

| 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 |



Addition of boric acid for inhibiting air reactivity of anodes(plant scale results)

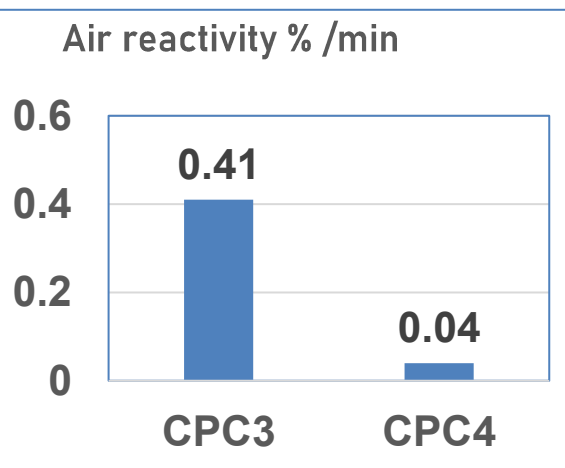
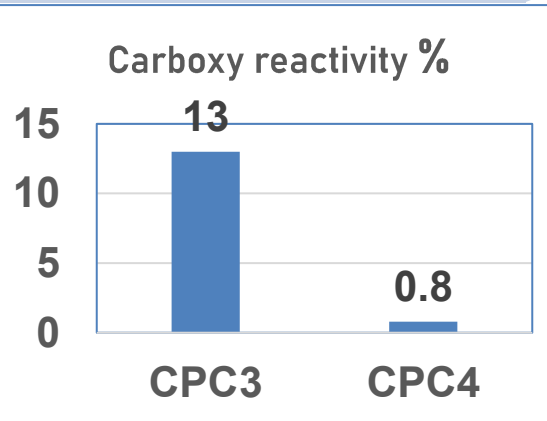


| | Before experiment | After experiment | Difference |
|---------------------------------------|-------------------|------------------|------------|
| %ARR Air reactivity residue of anodes | 61.6% | 85.2% | +23.6% |
| %ARD Air reactivity residue of anodes | 11.6% | 2.7% | -8.9% |
| %Boron in metal | 0.0022 | 0.0033 | +0.0011 |
| Avg Metal purity(% Al) | > 99.7 | > 99.7 | |

Reduction in Net carbon consumption & CO₂ emission - 3-4 kg/T & 13-14 kg/T equivalent ,resulting in saving of around Rs 5-7 cr/annum

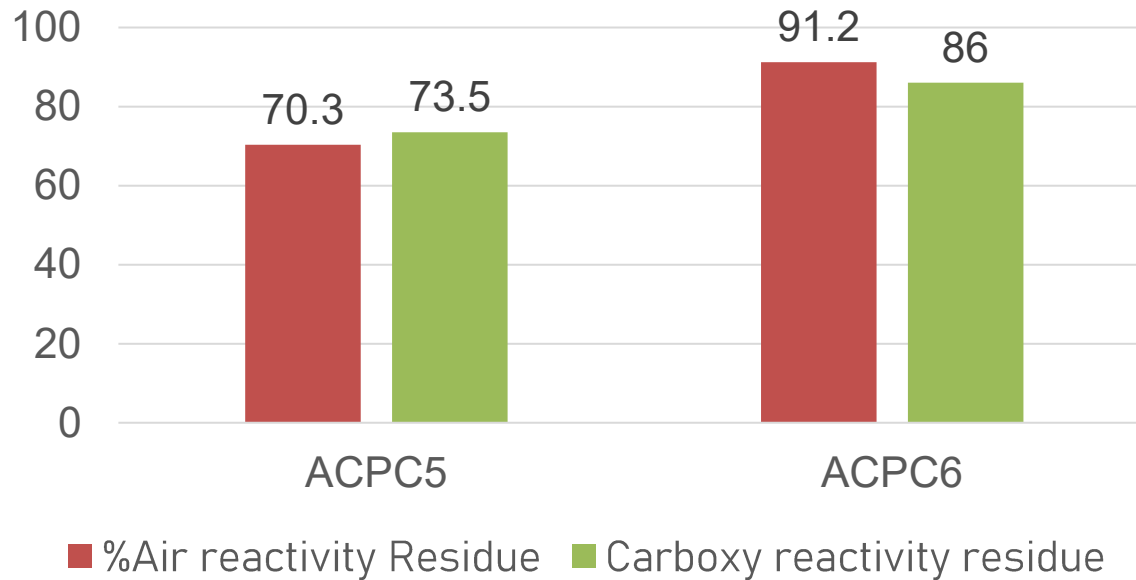
Inhibitor addition in CPC at Coke Calcining plant

| Properties | Unit | CPC3 | CPC4(doped) |
|----------------------------|-------------------|-------|-------------|
| 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 |



Test results of Anodes made from with and without doped CPC

Air reactivity & Carboxy reactivity of anodes made with CPC doped with inhibitor



Inert Anode (IA) Technology

- **Companies such as RUSAL and Alcoa–Rio Tinto (Elysis) are developing inert anodes.**
- **If successful, IA technology could eliminate carbon-related emissions. As per latest reports, few commercial scale experiments are being carried out at RUSAL.**
- **However, full scale commercial implementation still remains challenging .**
- **Thus, the role of carbon anodes used by the industry at present demands focused attention.**

References

1. Fisher,WK; Keller,F; Perruchoud,RC, Interdependence between net carbon and potdesign, operating parameters and anode properties, in Light Metals, TMS, Warendale, USA,1991, pp681-686
2. Binuta Patra and R.K.Barik -Studies on impact of calcined petroleum coke from different sources on anode quality in TMS 2012 - Light Metal-2012, USA
3. Binuta Patra and A. Palchoudhury -Improvement in oxidation behaviour of anodes in NALCO smelter plant by- ICSOBA 2017 at Germany
4. Binuta Patra - Impact Of Quality Changes In Calcined Petroleum Coke (Cpc) On Anodes Used For Aluminium Production, Icsoba 2020 (virtual), open access publication
5. Marta Ambrova ´ , Michal Korenko, and Lo'rant Szatma- Influence of the Sulfur Species on the Current Efficiency and Carbon Consumption in the Aluminum Electrolysis Process , Metallurgical and materials transactions volume 54B,October 2023

Conclusions : Strategies to mitigate the impact of quality changes in CPC

At Calciner End: Key Quality Control Measures

- **Understanding Quality Impact:**
Coke calciners must have a clear understanding of how CPC quality influences anode characteristics and, consequently, the overall efficiency of the electrolysis process
- **Optimized Blending of RPC:**
Ensure proper blending of Raw Petroleum Coke (RPC) from multiple sources to consistently meet anode-grade Calcined Petroleum Coke (CPC) specifications.
- **Controlled Calcining Temperature:**
Maintain strict control over calcining temperatures, tailored to the volatile matter content and impurity levels present in different RPC batches.
- **Consistency in CPC Supply:**
Supplying CPC with consistent and appropriate quality is critical for stable downstream performance.
- **Stringent Quality Assurance:**
Implement robust quality control systems and rigorous testing protocols at the calciner stage to ensure reliability and uniformity.

Conclusions : Strategies to Address CPC Quality Variations

At Smelter End: Key Considerations :

•Strategic Coke Blending at Smelter Level

Smelters should adopt a well-defined blending strategy to minimize variability and ensure uniform anode performance.

•Optimized Baking Parameters

Strict control of anode baking temperatures is necessary to achieve desired physicochemical properties.

•Improved Anode Covering Practices and Process Monitoring

Adoption of better covering techniques along with real-time (online) monitoring systems can significantly enhance anode quality and reduce defects.

•Robust Quality Control Systems

Implementation of stringent quality control and testing protocols at smelter is critical for maintaining consistency.

•Optimization of Fines in Dry Aggregate

Reducing the percentage of fines while maintaining a higher Blaine number (surface area) can improve anode density and strength.

•Higher Green Paste Mixing Temperatures (where feasible)

Increasing mixing temperatures can enhance binder distribution and improve paste homogeneity.

•Use of Additives

Incorporation of oxidation inhibitors, anode coatings, or other additives may be considered based on operational requirements.

•Development of Tailored CPC Specifications

Formulating CPC specifications specifically suited to the needs of the Indian aluminium industry will help address raw material variability and improve overall process efficiency.

THANK YOU