

Perfluorocarbon (PFC) Management Project

Aluminum Forum
December 2008 - Sanya

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Flagship Project

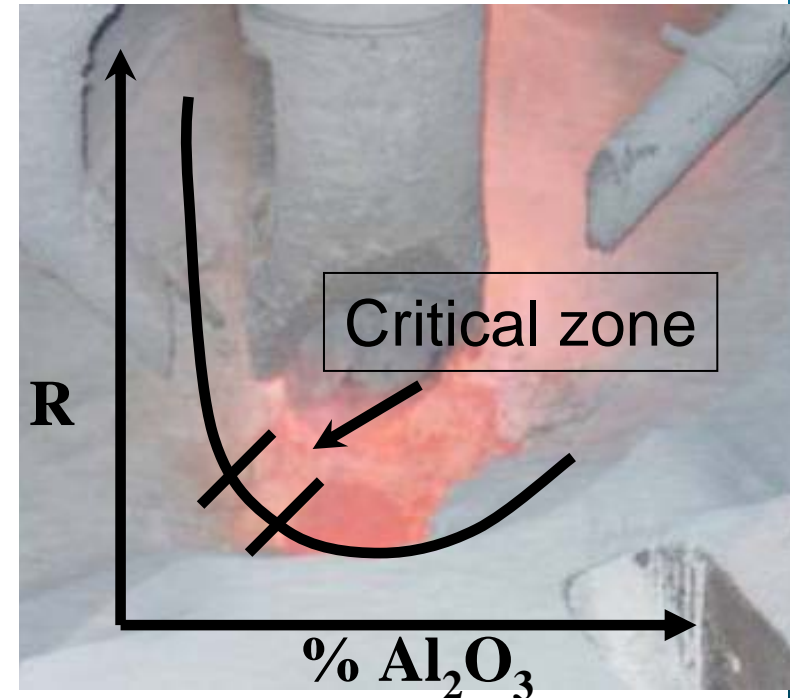


- Goal: Reduce PFC Emissions which result from Anode Effects (AEs)
 - Total emissions vary with frequency and duration of anode effects
 - Reductions come from improved process management, upgrades to computer control systems,
- Enable APP primary producers to achieve global performance standards for anode effects
 - Share information on best practices to reduce anode effects
 - Collect & report comparable high quality data
- China and the US share lead for PFC Project development and implementation
 - CNIA leadership and coordination
- Australia, China and US have committed approximately US\$1 mil
 - Training, tools and industry resources

What Causes Anode Effects?



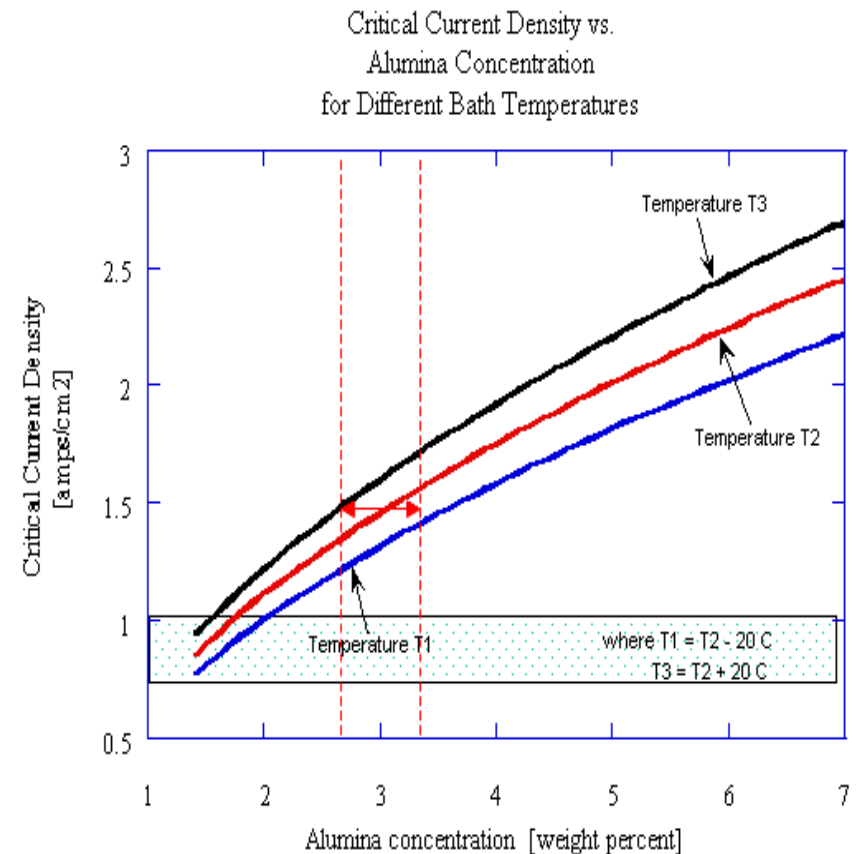
- Depending on the type of feed technology and strategy utilized,
 - the dissolved alumina content in bath is typically controlled between 2.0 to 3.5 % by slight under-feeding and over-feeding
- Anode effects are a predictable (but random occurring) phenomenon in aluminum reduction cells that result when the dissolved alumina concentration declines below a critical level, <2% in bath.



Anode Critical Current Density

AE results when the anode has exceeded its critical current density (ccd)

- Critical current density decreases as the bath temperature decreases in cells.

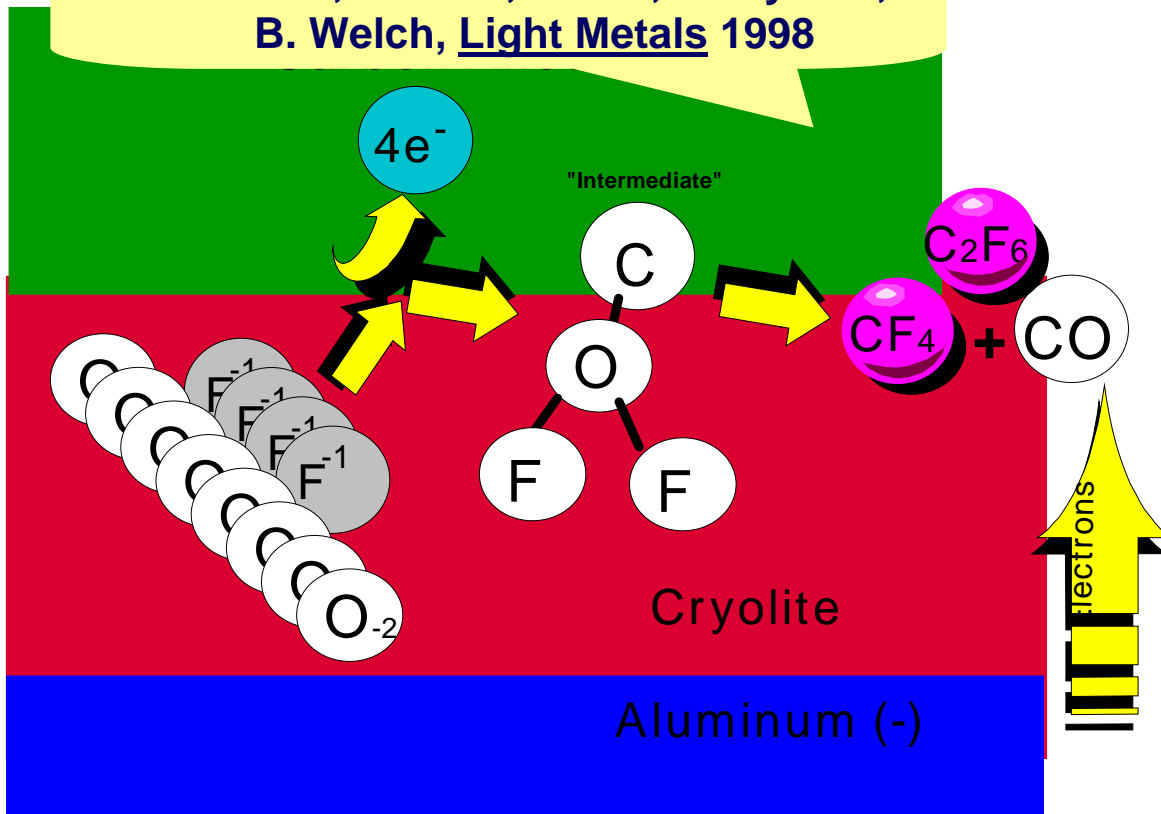


Generation of PFC Gases During Anode Effect



M. Dorreen, D. Chin, J. Lee, M. Hyland, B. Welch, *Light Metals*, 1998

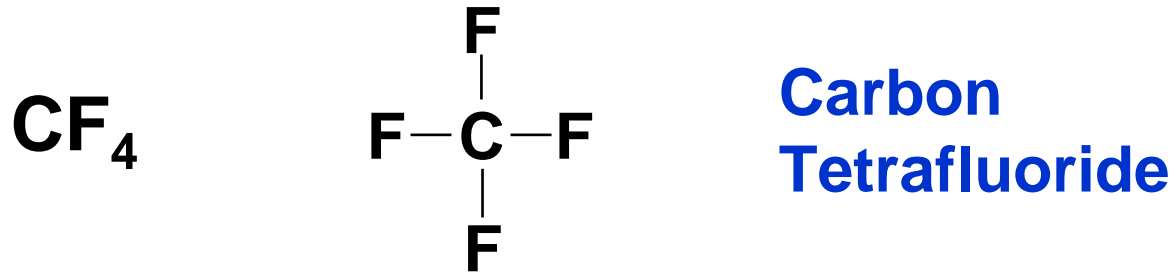
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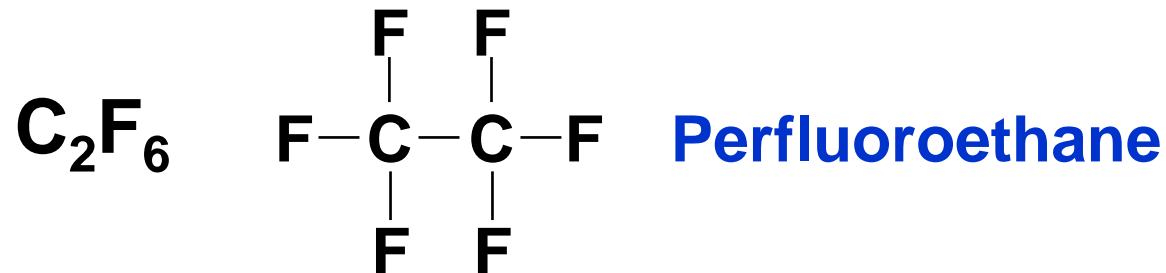
- The carbon anode preferentially reacts with the fluorine in the bath to form perfluorocarbon (PFC) gases because there is insufficient oxygen available from the alumina

Formation of PFCs During Anode Effect

Perfluorocarbon (PFC) Gases



Origin: 90% Al industry, 10% semiconductor industry



Origin: ≈100% Al industry, small amount from semiconductor industry

Why Worry about PFCs?



Compound	Atmospheric Lifetime (Years)	Global Warming Potential (100-year time horizon)*
CO₂	200	1
CH ₄	12	23
HFC-134a	14	1,300
CF₄	50,000	5,700
C₂F₆	10,000	11,900
SF ₆	3,200	23,900

*Intergovernmental Panel on Climate Change Third Assessment, 2001

- Irreversible atmospheric impacts
- Aluminum sector one of top emitters of PFCs
- APP Countries more than 50% global production
- Anode effects indicate process inefficiency

PFC Project Priorities



- Training to improve operational practices
 - Facility managers and pot room operators
 - Benefits of PFC management
 - Anode effect reduction techniques
- Establish emissions baseline
 - Track anode effect frequency and duration
 - Benchmark performance
- Report annual data
 - Track progress using consistent and comparable data
 - Participate in IAI Anode Effect Survey
- Facility-specific PFC measurements
 - Improve domestic and global inventory accuracy
 - Key data for managers

PFC Project Workplan



- Five key activities
 - Study Tours
 - Demonstration Projects
 - PFC Measurements
 - Data for National and IAI Inventories
 - AE Kill Sequence Computer Algorithms

Study Tour



- 2008 Rio Tinto Alcan Bell Bay Smelter in Tasmania
 - Collaboration of Australian Aluminium Council, Australian Government, CNIA
 - Participants from: Shanxi Huasheng Aluminium, Yichuan Henan, Shaanxi Tongchuan Aluminum, Sichuan Aostar Aluminum
- Develop strategies and steps to avoid and reduce duration of AEs
 - AE performance and strategies for RTA smelters
 - Demonstration of automated AE termination
 - Best practices for manual AE kill
 - Identify key projects for delegate smelters
- 2009 Study Tour in Australia
 - Additional tour(s) planned for 2009/10
 - CNIA coordinates Chinese participants

Demonstration Project



- 2-day training course for Managers and Senior Engineers
 - Intensive On-site Training with International Experts
- Program elements
 - Study tour participation
 - Facility training on best practices to avoid AEs
 - Support efforts to adopt computer squelch sequence
 - PFC Measurement
 - Follow up visit for progress update and analysis of pot room parameters
 - Report data thru CNIA to annual IAI AE Survey
- 2008 On-site intensive training at two smelters
 - Yichuan Henan Yuganglongquan Aluminum, Luoyang City
 - Shanxi Huasheng Aluminum, Yongji City
- 2009 – Complete training at 2 -6 facilities
 - CNIA coordinates schedules

Best International Technical Experts



Dr. Jerry Marks

- PFC Consultant for IAI
- Chair of IPCC Inventory Methods
- Completed over 60 PFC measurements world-wide

Dr. Alton Tabereaux

- 30+ years Reynolds and Alcoa
- Key leader in launch of 1995 US voluntary PFC reduction effort
- Multiple patents, Contributing Editor of Light Metals Age

Dr. Zhang Hao

- Senior Research Scientist Rio Tinto Alcan
- Seamless translation

April 2008 Pilot Demonstration Launch



PFC Measurements



- 5-7 day monitoring of smelter emissions using FTIR
 - Does not effect on-going operations
 - No cost to smelter
 - Data is confidential
- International and CNIA experts
 - Use EPA/IAI Standard Measurement Protocol
- Measurements completed at:
 - Yichuan Henan Yuganglongquan Aluminum Company
 - Shanxi Huasheng Aluminum Company
 - Shandong Nanshan Aluminum Company
 - Hunan Chungyuan Aluminum Company
 - Hubei Danjiangkuo Aluminum Company

Automated Squelch Sequence



- Reduce AE duration from minutes to seconds
 - Manual kill using green pole expensive and dangerous for workers
 - Automated kill saves money, reduces PFCs
- Technical support for implementation (design, trials, optimization) at smelters
 - Institute for Governance and Sustainable Development
 - Technical team led by world-renowned expert – Dr. Alton Tabereaux
- Work with up to 30 companies over 3 years
 - 2008 Launch at Henan Zhongfu Aluminum, Gongyi City

Inventory and Data Collection



- “If you do not measure, you cannot manage”
- Provide tools and resources for anode effect process data tracking and inventory to support smelter strategies and benchmark industry progress
- Typical AE data collected by smelters:
 - AE detection date and time
 - Duration above detection threshold
 - Total duration until cell back at target
 - Maximum voltage reached
 - AE energy
 - Feed state at AE
 - Operation occurring at AE (eg track, tap, set)
 - AE termination result
- Adopt International Aluminium Institute (IAI) global method and standards
 - Consistent and comparable data

Activities for All Companies



- Establish Baseline Emissions
 - Use IAI Inventory Protocol
 - Invite PFC Measurement thru APP
- Set emission reduction goal
 - Motivate managers, workers
- Collect the right data
 - Anode frequency and duration
- Track progress
 - Report data through confidential IAI Benchmarking Initiative
- Contact CNIA about APP Project Participation

Benefits of Reducing AE Frequency



- Reduced greenhouse gas emissions
- Reduced energy consumption
- Improved current efficiency
- Reduced crust disruption & collapse from AET squelching
 - helps reduce airburn
 - Helps reduce fugitive fluoride emissions
- Demonstrates control of process
- Reduced manual intervention to “pole” out failed anode effects
 - Operator safety
- Reduced bath spillage onto floor
 - Operator safety
 - Reduced floor damage
 - Reduced cleanup, improved housekeeping
- Reduced disruption to other Potroom work to tend “failed” AEs
- Reduced risk of cell failure due to overheating
- Reduced incidence of disruption to normal operations
- “Gentler” on power supply equipment
- Improved amperage stability, reduced production loss, especially if multiple AEs cause significant reduction in current
- Reduced fluoride fugitive emission

Power of Voluntary Action



- Assure Customer Confidence
- Earn Trust of Workers, Government and Communities
- Lower Cost of Production
- Sustainable Future for Aluminum
- Protect the Environment for Our Children

Questions and Contacts



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