

Toward Chlorine-Free🌱 Casting :

Metallurgical Evaluation of the AluCLEAN™ Rod

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STAS



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About the Presenter

- **Yanick Boulianne, P.Eng., MBA**
 - Product Manager @ STAS
- **10+ years of experience in the aluminum industry:**
 - Anode rodding shop and Casthouse operations @ Alcoa, Baie-Comeau smelter
 - High Purity Aluminum @ Nature Alu
- **Co-author:**
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About STAS

- Who are we?
 - Canadian fully integrated OEM company specializing in equipment and process solutions for the global aluminum industry.
 - From carbon to casthouse, we design and supply technologies for primary and secondary aluminum producers

140

EMPLOYEES

1500+

**UNITS
DELIVERED**

40+

COUNTRIES



Content

1. Why is chlorine used in aluminum production?
2. The downsides of gaseous chlorine
3. Alternative to gaseous chlorine
4. What is AluCLEAN™ ?
5. Metallurgical evaluation of AluCLEAN™
6. AluCLEAN™ or FFD, what is the best option?
7. Conclusion



Why is chlorine used in aluminum production?

- Alkalis (Na, Ca and Li) and inclusions are undesirable impurities that cause defects in aluminum semi-finished products such as rolling slabs, billets and wire/rod.



AA5182 edge cracking caused by excess Na during hot rolling and after coiling

Doutre & Wycliffe, *Materials Science Forum*, 2011, Vol. 693, pp 256-263

Why is chlorine used in aluminum production?

- For decades, the industry has relied on chlorine fluxing techniques to remove these impurities from aluminum.
- Chlorine fluxing can be done at two (2) locations:

1. Furnace:



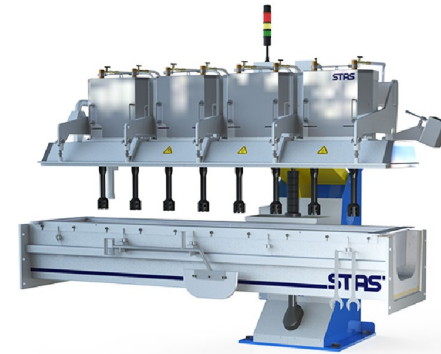
Manual lance fluxing

<https://www.youtube.com/watch?v=Acj8QLerwmg>



RGI / Rotary Gas Injector ®

2. Degasser:



Cl₂ injection through rotors

Primary control of alkalis and inclusions

Secondary control of alkalis and inclusions

The downsides of gaseous chlorine

1. Health and Safety :

- Irritating gas, toxic, HCl emissions

2. Environmental constraints :

- Control of atmospheric emissions and reporting obligations

3. Maintenance costs :

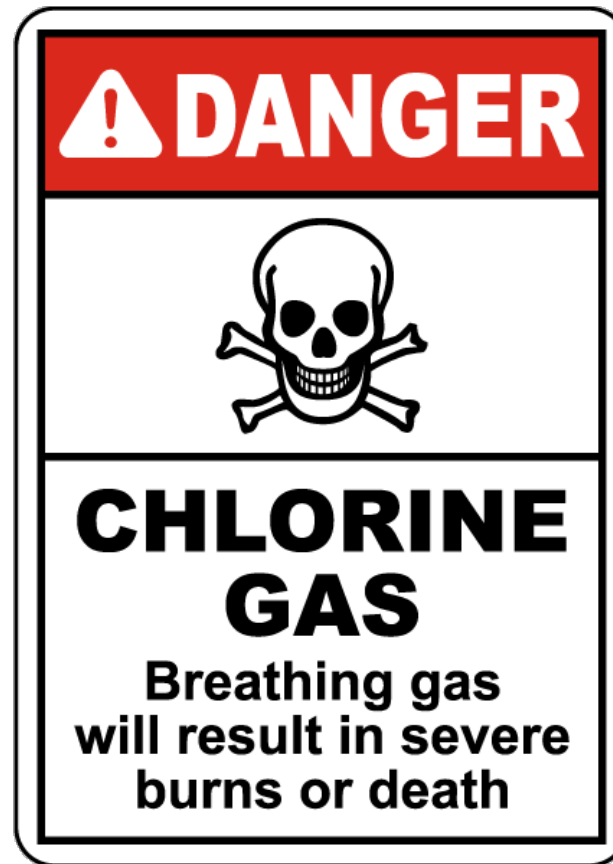
- Corrosion (ducting, fan, steel structures, instruments), dedicated chlorine room, extensive safety training, specialized safety equipment

4. Loss of productivity :

- Cl₂ alarm = aborted casts



Is chlorine really worth it?



Alternative to gaseous chlorine

- ✓ Salt fluxing delivers as good or better metallurgical performance as gas fluxing, both in furnace and degasser ^{1 2}.

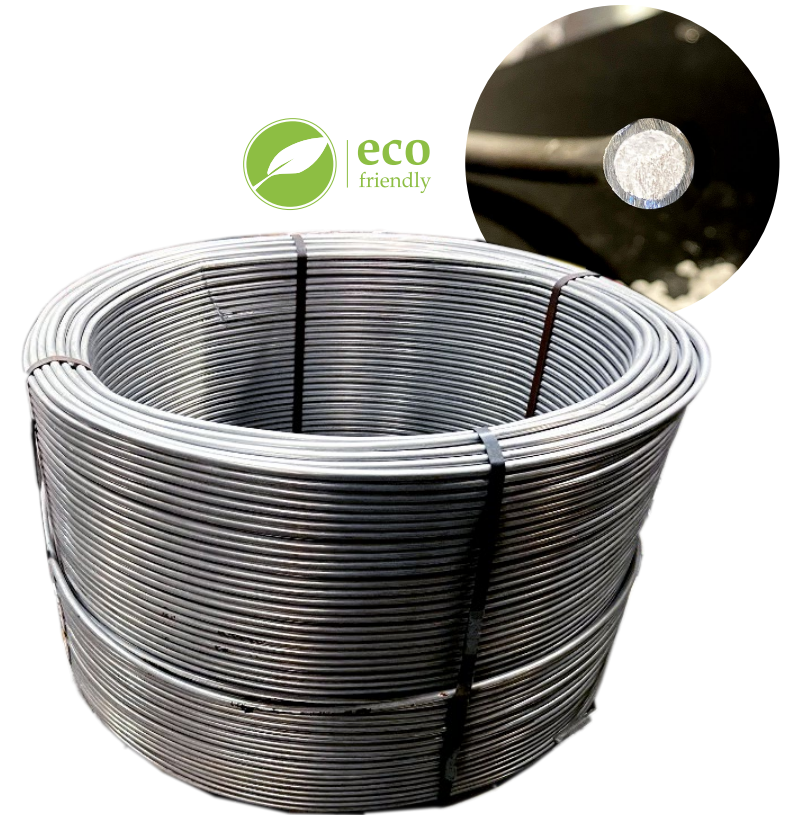
¹ R. Bridi and M. Smith. Improvements in casthouse processing using in-furnace refining systems. 8th Australian Aluminium Casthouse Technology Conference (2003)

² D.C. Chesonis and D. DeYoung. Chloride salt injection to replace chlorine in the Alcoa 622 degassing process. Light Metals (2008)

Fluxing Location → Fluxing Process ↓	Furnace	Degasser
Gas	Lance, porous plugs, RGI	Cl ₂ through rotors
Salt	Manual bag addition, lance, RFI	FFD, AluCLEAN™

What is AluCLEAN™?

- Patented refining rod that improves aluminum quality by reducing the level of alkalis and inclusions
- Fused flux composed of 40% KCl + 60% MgCl₂ encased in an aluminum sheath
- Must be injected inside the degasser (near the first rotor)
- Compatible with any degassing system and with any standard grain refiner feeder



What is AluCLEAN™?

- AluCLEAN™ dedicated feeder is very easy to operate (2 to 40 in / min)
- Salt remains completely dry until injection
- Reduced dross generation, dryer dross and reduced thermite reactions 
- Produced in the USA
- Sold in 5000 ft coil format
- Five (5) plants are currently using AluCLEAN™



Metallurgical evaluation of AluCLEAN™

- Trial summary:

- Location:  HULAMIN Campsdrift, Pietermaritzburg, South Africa
- Date: January 12th to 16th 2026
- Casting Line: DC1 (rolling slabs)
- Alloy:
AA3104: 2 casts with Cl₂ and 2 casts with AluCLEAN™
AA6061: 3 casts with Cl₂ and 3 casts with AluCLEAN™
- Objective: Demonstrate that AluCLEAN™ can replace the use of chlorine gas in the degasser by having a comparable or superior reduction of inclusions, alkalis and hydrogen.

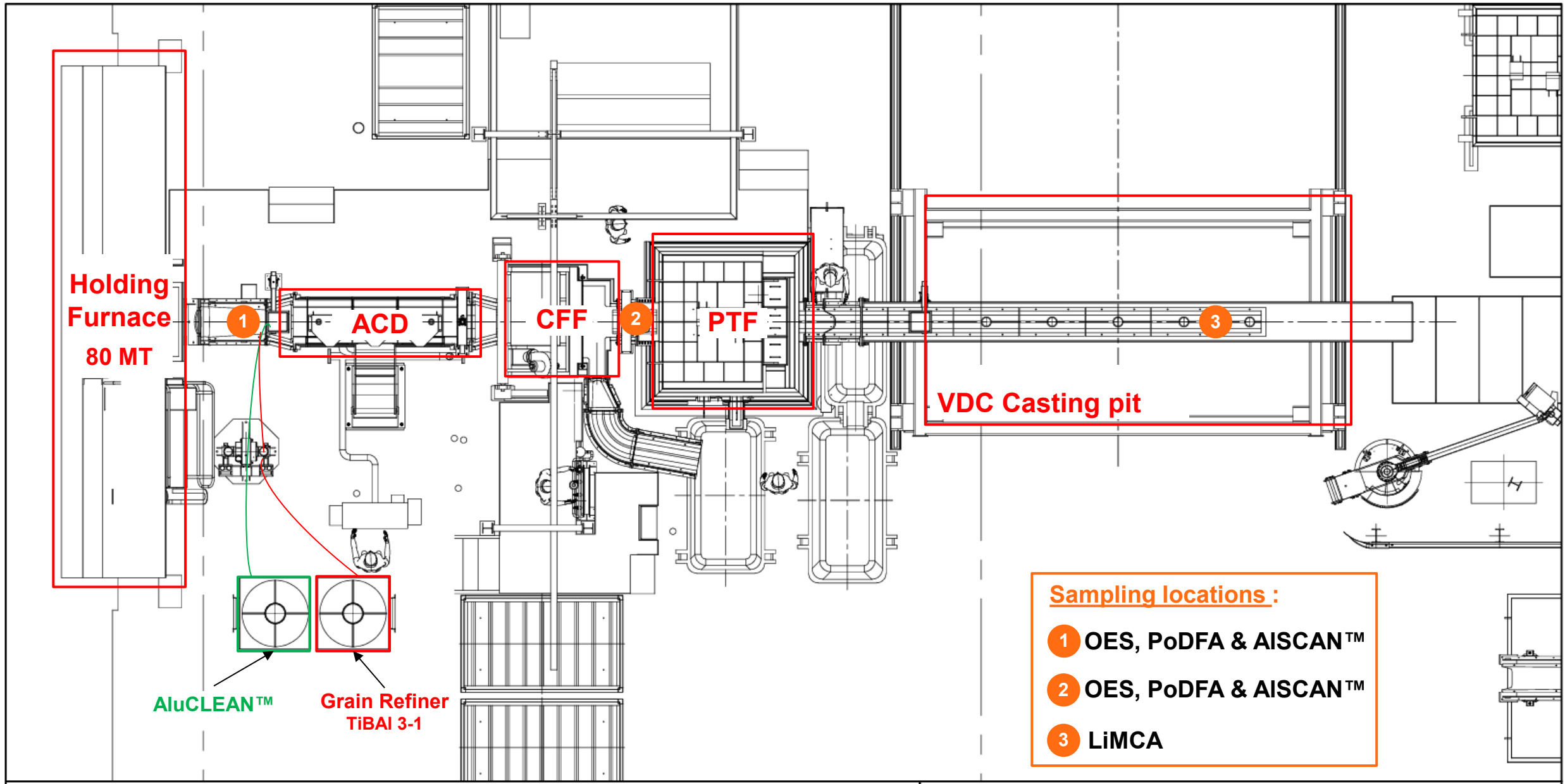


Metallurgical evaluation of AluCLEAN™

- Evaluation criterias:

Criteria	Parameter(s) analyzed	Analysis method	Sampling location(s)
Alkalis	Na concentration (ppm) Ca concentration (ppm)	Spark-OES	Before degasser After CFF
Inclusions	Inclusion count N20 (K/kg)	LiMCA	Casting table
	Inclusion content (mm ² /kg)	PoDFA	Before degasser After CFF
Hydrogen	H ₂ concentration (ml H ₂ /100 g Al)	AISCAN™	Before degasser After CFF





Metallurgical evaluation of AluCLEAN™

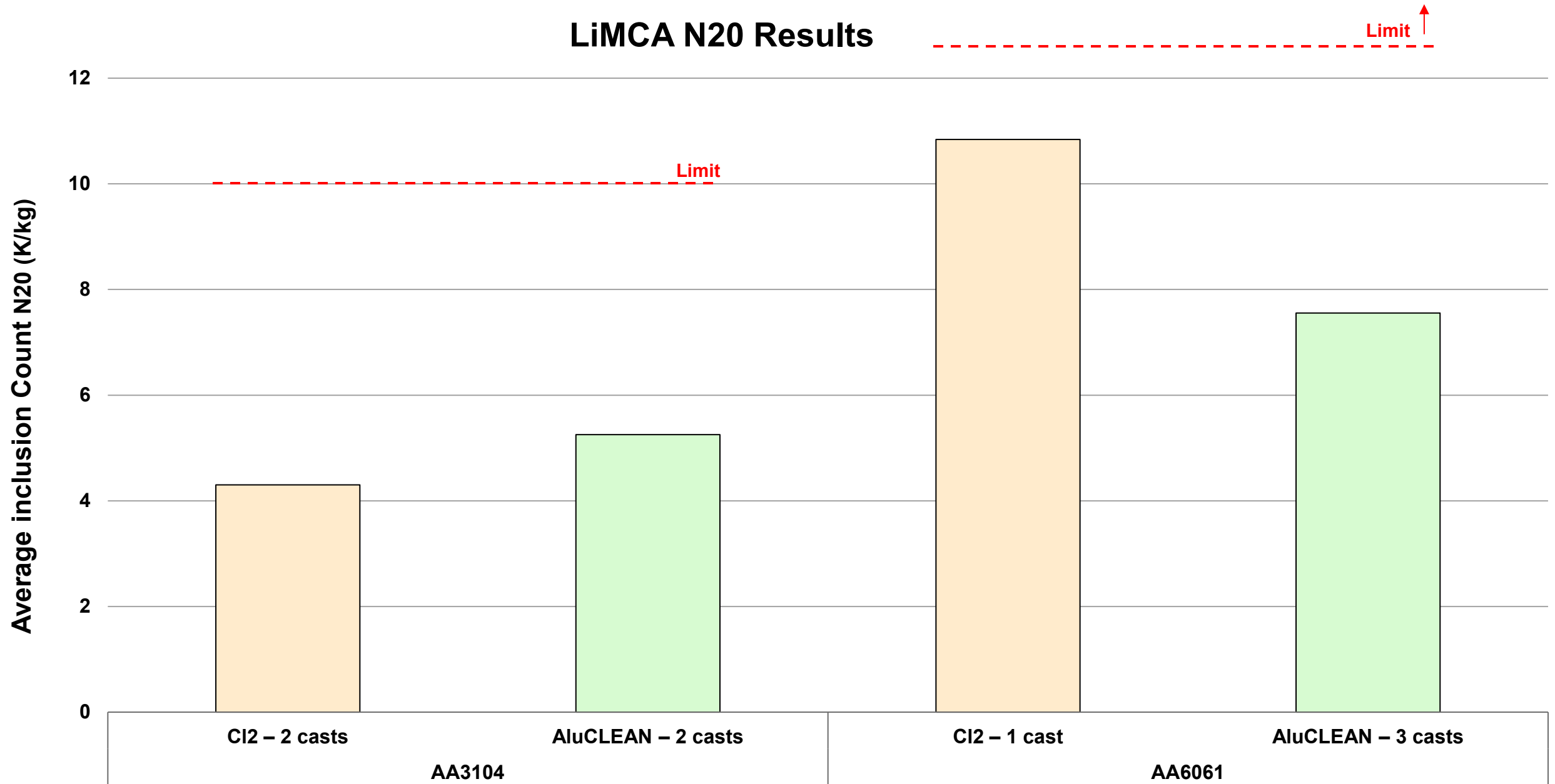


AluCLEAN™ feeder setup

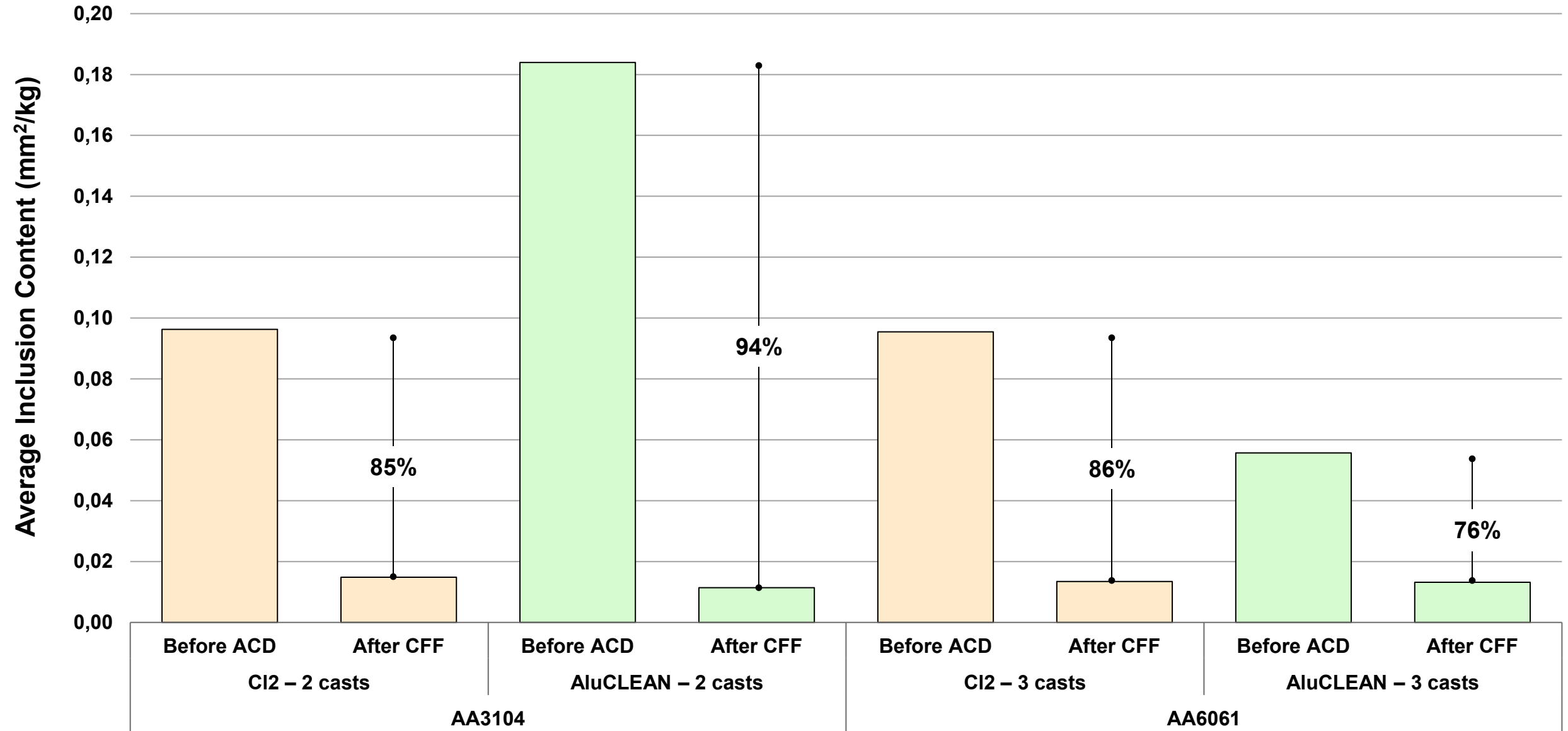


AluCLEAN™ rod injection in the ACD

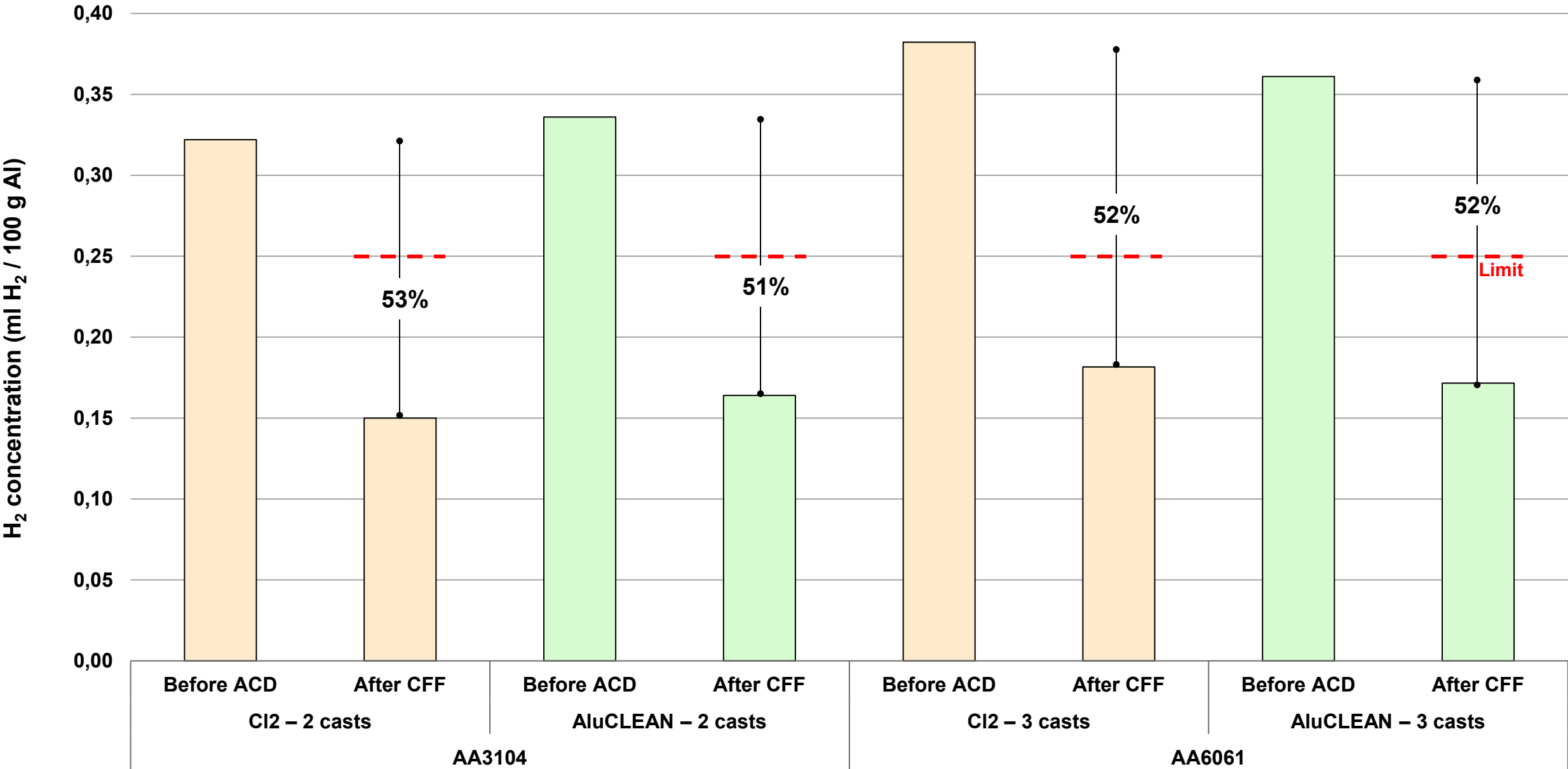
LiMCA N20 Results



PoDFA Analysis Results



AISCAN Results



What about the alkalis (Na and Ca)?

- Na and Ca concentrations were below 1 ppm after RGI treatment in the furnace.
- Below 1 ppm, it's not possible to draw a meaningful conclusion about reduction efficiency.
- RGI treatment time was reduced by more than 80% but alkalis were still below 1 ppm.
- Low alkalis level mainly due to the high proportion of scrap metal remelted as compared to prime.



Metallurgical evaluation of AluCLEAN™



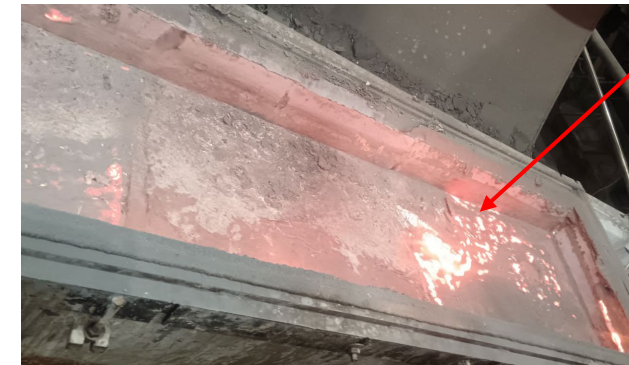
AA3104 AluCLEAN™



AA3104 Chlorine



AA6061 AluCLEAN™



AA6061 Chlorine

Thermite

Metallurgical evaluation of AluCLEAN™

- **Conclusion:**
 - LiMCA and PoDFA results showed comparable inclusion reduction for both chlorine and AluCLEAN™.
 - AISCAN™ measurements indicated similar hydrogen removal performance between chlorine and AluCLEAN™.
 - However, due to the very low initial alkali levels, it was not possible to draw a definitive conclusion regarding the alkali reduction performance of AluCLEAN™.
 - Hulamin was satisfied with the results and requested to keep the feeder for trials on AA5182. They will transition to chlorine-free operations by 2028 by replacing their RGIs with RFIs and implementing AluCLEAN™ across all three (3) lines.

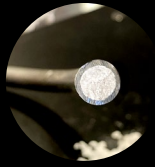




The AluCLEAN™ trial team: Spectrum Technical, Hulamin & STAS

AluCLEAN™ or FFD: what is the best option?

- It depends...

Criteria	AluCLEAN™ 	FFD 
Method of injection	Rod fed into the degasser	Flux conveyed through a rotor
Rapidity of installation	Very fast	Few days
Simplicity of use	High	Moderate
CAPEX	\$	\$\$\$
OPEX	\$\$	\$

- For customers who need flux treatment in their degasser only on selected alloys, AluCLEAN™ is likely the best choice.
- STAS works with customers to determine the right solution for their situation.

Conclusion

- The trials demonstrated that AluCLEAN™ can achieve inclusion removal and hydrogen reduction performance comparable to gaseous chlorine under real production conditions.
- Future work should include trials under higher alkali baseline conditions to fully assess the alkali removal efficiency of AluCLEAN™.
- STAS is the only supplier that can provide the equipment for a chlorine-free casthouse or to eliminate gaseous chlorine from existing operations.



RFI / Rotary Flux Injector ®



FFD / Flux Feeder for Degasser ®



PurAAL™



AluCLEAN™