



Can high purity alumina be sustainably produced?

Advanced Energy Minerals details how its unique chlorine leach-crystalline purification process can reduce the carbon footprint of high purity alumina production

HOW can high purity alumina be produced sustainably? **Advanced Energy Minerals (AEM)** considers sustainable production to be of the utmost importance.

The company manufactures ultra-high purity alumina (HPA) at its production plant in Cap-Chat, Quebec, Canada, that delivers under the **SupALOX™** brand.

How HPA production increases carbon emissions

It is well known that the conventional alkaloid process for manufacturing HPA is a notorious 'energy hog', yielding a typical carbon footprint of 12.3 tonnes of CO₂ emitted per tonne of high purity

alumina. This is an incredibly high ratio compared even to the energy consumption within the cement and steel industries with their ratios of only 0.6 and 1.85 tonnes of CO₂ emitted per tonne of cement^{2,3} and steel^{4,5,6}, respectively.

The alkaloid process for high purity alumina also relies on expensive, carbon-intensive aluminium metal as its feedstock, which clearly will not be acceptable in the future.

Shocked by numbers like these, consumers and investors are making decisions based on sustainability. For example, the Norwegian sovereign



High purity alumina takes on different crystalline structures known as alpha (α), beta (β), and gamma (γ), with each possessing different properties. α -HPA has a low specific surface area and is very resistant to high temperatures. Because it is inert, it has almost no catalytic activity. γ -alumina has excellent dispersion and a higher specific surface area, but it is inert and provides high activity⁹.

Emissions Scopes according to the Greenhouse Gas Protocol^{10,11}

Scope 1 Emissions from sources that a company owns or controls directly.

Scope 2 Emissions that a company causes indirectly when the energy it purchases and uses is produced.

Scope 3 Emissions not produced by the company itself, and not the result of activities from assets owned or controlled by them, but by those that it is indirectly responsible for, up and down its value chain. Scope 3 emissions include all sources not within the boundaries of Scopes 1 and 2.

Reducing the industry's carbon footprint

The first step in reducing the carbon footprint and environmental effects of the HPA industry is to reduce the power requirement for manufacturing processes. This starts with the design of the processes and the manufacturing plant to implement them. As a basis to reduce power consumption, hydro metallurgy processes use much less power than thermal process steps.

AEM's proven chlorine leach–crystalline purification (CLCP) process currently emits 12% fewer carbon emissions than the alkaloid process and is expected to reduce to zero in Q3 of 2023. Close co-operation with the laboratory is the basis for continuous improvement in the plant. This provides the plan for eliminating the Scope 1 category of emissions.

The CLCP process produces almost zero waste. Hydrochloric acid, an important input chemical, is recycled many times within the process before being

fund – one of the largest sustainability projects with more than €1.1tr invested⁷ – now requires each of the 9,000+ companies it invests in to show plans to reach net zero by 2050⁸. Therefore, it is clear that the alumina industry needs an alternative to manufacture 99.999%-pure 5N HPA at a competitive price.

The market has a strong demand for HPA that will increase rapidly in years to come. This is because HPA has excellent properties in terms of chemical stability, its high melting point, and high mechanical strength and hardness. It has good thermal conductivity but high electrical insulation.



AEM's Manufacturing

Scope 2



Scope 1



AEM's CO2-reduction measures. Only green energy used



Product Carbon Footprint (CFP)

Scope 3



Scope 2



Scope 1



Products with ZERO CFP





discharged. As a by-product, it predominantly takes the form of aluminium chloride, which is sold for use in water treatment. The water from our processes that we do not recycle is treated and released under strict guidelines.

The next step is to source the required power from green sources. A location rich in hydropower and wind farms is of the essence. This leads to both predictable pricing and fulfilment of environmental criteria. By-products are produced with hydropower and, as a result, there are no Scope 2 emissions.

Manufacturing high purity alumina does not occur in a vacuum. This means that reducing Scope 3 emissions requires paying attention to the inputs and outputs of production. The feedstock must arrive and bring with it a carbon footprint of zero. This can be achieved if the supplier uses hydro or wind power exclusively, ideally within the company from its dams or wind installations. It is, of course, simplest if the supply is from a secured source located nearby. An alternative feedstock is aluminium from decommissioned factories.

The product going out must match the customers' requirements exactly so that they can minimise their process steps and maximise their productivity. This means that high purity alumina cannot be seen as a commodity product where the customisation is left to the customer, a wide and versatile product portfolio is needed. Powder particle size can be controlled both at the crystal-growing stage and via subsequent milling – although the latter requires careful control to avoid contamination by the grinding media. Powder must be tailored to a customer's specific requirements for particle size, densification, and doping. Pellets (compacted powder in a 'puck' shape) must also meet exacting specifications to fulfil their applications.

Looking ahead

Customisation to meet special requirements involves simulation, development in the laboratory, and transfer to production. Quality controls after manufacturing complete the technical involvement to the benefit of the customer, with a location convenient to North American and European markets that simplifies shipping.

Even if the site is not in a location where every turn of a spade is audited and certified, transparency must be maintained for internal and external purposes. All systems are running to identify where things come from and where they are going and logging of operations is ongoing in preparation for internal and external audits.



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As we have seen, sustainability depends on many factors. Process design, the reduction of power requirements, an advantageous site, green energy sources, clean feedstocks, and customised products are all important to sustainably produce and deliver ultra-high purity alumina.

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