Alcoa develops carbon capture process

 Alcoa has achieved a breakthrough with an innovative process that simultaneously addresses greenhouse gas emissions and opens the way for sustainable re-use of bauxite residue. Alcoa plans to deploy its new carbon capture technology at its refineries around the world.

Carbon capture is a textbook example of sustainability because it reduces greenhouse emissions at the same time as turning waste products into useful resources

Developed in Australia by Alcoa's Technology Delivery Group, the process works by mixing carbon dioxide into the bauxite residue from aluminium production - forming stable inorganic minerals and 'locking in' CO_2 that would otherwise be emitted to the atmosphere.

Residue treatment plant creates a carbon sink

Alcoa's first residue carbon capture plant is operating at Kwinana in Western Australia, and currently uses a high-concentration CO_2 stream from a nearby ammonia plant. The process is capturing and storing almost 70,000 tonnes of CO_2 a year - the equivalent to taking 17,000 cars off the road.

The long-term plan is to deploy the carbon capture technology at Alcoa's other refineries around the world - in the Australian refineries alone, this could permanently store as much as 300,000 tonnes of CO_2 a year.

Although this first-of-a-kind plant has used offsite emissions, Alcoa expect most of their other carbon capture plants will use CO_2 from on-site powerhouse emissions.

The Kwinana carbon capture plant was built in 2000 and initially operated as a trial facility. For the last two years, it has carbonated around 25% of the Kwinana refinery's residue output. Construction of a CO_2 pipeline in 2007 has allowed throughput to be increased to 80% of the refinery's residue output with plans to increase it further to 95%.

In addition to the greenhouse benefits, the Residue Carbon Capture process also paved the way for bauxite residue to be re-used as a value-added resource rather than being stored as a waste product.

"Carbon capture is a textbook example of sustainability because it reduces greenhouse emissions at the same time as turning waste products into useful resources. We are now researching opportunities to re-use carbonated residue in road base, building materials or soil amendments", said Alcoa Residue Development Manager, Dr David Cooling.

Dr Cooling has headed up the development of the carbon capture process and is a member of the Alcoa Technology Delivery Group, Alcoa's global research and development centre for alumina refining.

Turning residue into a value-added resource

Residue management is a key sustainability issue for the aluminium industry because of residue volumes and long-term storage requirements.

Up to two tonnes of bauxite residue are generated for every tonne of alumina produced.

Sometimes described as 'red mud', the residue is a mixture of minerals that are left behind when the alumina is removed from the bauxite. While it is thoroughly washed at the refinery, it still contains some alkaline liquor which has limited its potential for re-use and required it to be stored in lined storage areas.

Mixing concentrated CO_2 into the residue reduces its pH level from 13.5 to 10.5. At this level of alkalinity, the residue presents a significantly lower environmental risk and has the potential to be re-used as a value-added resource, for example in road base, building materials or soil amendments.

In Australia, Alcoa is sponsoring research into re-use opportunities by the Centre for Sustainable Resource Processing and other organizations.

Other environmental benefits

In addition to its greenhouse benefits, Alcoa's residue carbon capture process delivers other economic, environmental and social benefits:

- Less dust. Carbonated residue produces less dust than uncarbonated residue which delivers benefits for neighbours and reduced water usage for dust suppression.
- Reduced storage area. This project reduces the area required for residue storage and drying by up to 15% because carbonation speeds up the drying process and carbonated residue is structurally stronger than uncarbonated residue.

- The smaller operating footprint also reduces the potential for dust and amount of water required for dust suppression.
- Biological removal of sodium oxalate. The success of residue carbonation has allowed Alcoa to develop a downstream process that uses the natural bacterial activity in the carbonated residue to destroy sodium oxalate.
- Sodium oxalate is an organic by-product which must be removed from the refining process and historically it has been treated in a kiln.

Development work at Kwinana over the last five years has shown that sodium oxalate can be biodegraded by natural bacterial activity in the carbonate residue. This can occur because carbonation allows the residue bed to build up naturally-occurring bacteria.

Any residual oxalate which drains off the carbonated residue before it can be broken down will be able to be treated in a bioremediation plant which also uses "friendly" bugs. The bioremediation plant is under construction.