Ever wondered whether it was possible to produce alumina without resorting to the Bayer process? It’s a subject that has kept Richard Boudreault, president and CEO of Orbite Aluminae, very busy – and now he’s perfected a system that might revolutionise the aluminium industry. By Matthew Moggridge*

It all started with a type of red clay, said Richard Boudreault, founder of Orbite Aluminae. “A few years ago somebody came to us with a red mud problem; not red mud in the true sense of the phrase, but a type of red clay,” he says. “There was about 25% of alumina in there and they wanted to know if we could do something with it. I said we could do a Bayer, but nobody would give us authorisation because the process is too polluting,” he continues.

A materials scientist by trade, Boudreault pondered the problem. “What if we were able to produce, not smelter grade alumina, but high purity alumina?” he thought, and started work on a solution. “I drew up a process by which we could produce high purity alumina, which was then digested with hydrochloric acid. So it was a very biological process and it became fairly obvious that it was possible,” Boudreault continues.

According to Boudreault, there’s no need to be overly cautious about cost with high purity alumina because it’s worth about a thousand times more than smelter grade alumina. He developed a process based on neutralising the acid with caustic soda – or NaOH – and getting rid of it. When the Canadian aluminium industry – the third largest producer in the world – got wind of Boudreault’s fledgling process, that phrase ‘corporate social responsibility’ was front-of-mind. “They said ‘this is great and it’s good for our CSR and we’ll support you because you’re doing alumina work and we have to give something to the Government in terms of job creation, so we’ll help you and then we can say we created those jobs’,” explained Boudreault.

Smelter grade alumina Canada needs smelter grade alumina, he said. “They say, ‘We don’t get supplied that often, we’re at the end of the production line and once in a while the boat doesn’t show up, it goes to China instead, and then we get into a bit of a turmoil’,” he added.

The current cost of smelter grade alumina is prohibitive, says Boudreault, as it’s produced from bauxite imported from Jamaica and East Africa at high cost. It generally takes three tonnes of bauxite to produce one tonne of alumina.

In recent years, Boudreault claims that Canada’s big mining companies – traditionally arch enemies – have been prepared to share ships rather than kiss goodbye to their process, so the idea of a new technology that could provide the Canadian industry with home-grown alumina was more than just intriguing. While Boudreault had established that his process worked there was a real need to recycle the hydrochloric acid. “If we were to release it into the environment, it would be too much and it would need a lot of NaOH to neutralise it,” he said.

The Orbite process extracts alumina and other materials from clay and eliminates red mud in the process. The red mud remediation process and the red clay extraction are basically the same process, meaning that one single plant can do both. To be able to reuse previously used acid, it was necessary was to clean the acid. “And when you do that you have to extract material that is still floating – magnesium, iron and other materials including a number of rare earths, such as scandium,” he added.

By extracting just the alumina, our cost to produce the alumina is around $210/tonne, but if the other materials are taken out it drops to $98/tonne.

“Essentially you have a negative cost alumina and that doesn’t make sense so...
It's a big environmental problem,” he said. “Producing alumina was the big thing, but we discovered two years ago that a lot of the pollutant materials we had to extract from aluminous clay were worth a lot of money. The iron is a 99.9% hematite, which is used to make magnets for electric motors, and one of the rare earths is scandium, which we expect to be the next revolution in the aluminium industry,” he explains, adding that the content of aluminous clay (red clay) is pretty much typical; other red clay samples contained similar alumina and by-product content.

So what exactly is Orbite Aluminae doing and why is it so revolutionary? The company has developed a process that Boudreault claims can extract alumina and other valuable properties, including rare earths and metal oxides – like Yttrium, Erbium, Scandium, Dysprosium, Neodymium, Gallium and Cerium – from clay and, ultimately, eliminate the Bayer methodology from the aluminium production process. In other words, you don’t need bauxite to make alumina.

Making Bayer obsolete

“This technology allows you to produce alumina locally from basic dirt in the ground such as clay, bauxite and kaolin. If you’ve got any of these materials, you’re in business. We can produce alumina from anything, including bauxite, but also a lot of different things. The Chinese are importing bauxite from Indonesia – they don’t need to do that anymore. They can produce it from their own backyard and save so much CO₂,” he says.

“We can produce alumina in any country in the world and the plant doesn’t have to be far from the smelter, so you eliminate all the costs of transportation,” Boudreault explains.

He claims that Orbite’s patented process will sound the death knell of the industry’s big nemesis: red mud.

"Aluminium, iron and silicon: the thing they want to do most is get married and form a threesome and when they lock together, they form red mud,” says Boudreault.

"The red mud which is produced from the Bayer process is essentially the formation of that threesome and it is near impossible to break up,” he added, explaining how the Bayer process allows the silicon, iron and aluminium to form and then float in a caustic solution in order to separate them. "So the first process you have out of the Bayer method is this pollution material and for every tonne of alumina you get two tonnes of red mud. It’s a big environmental problem," he said.

While using bauxite with a low iron and silica content is ideal, but the best refiners in the world still produce two tonnes of red mud for every one tonne of alumina.

Orbite’s solution is to place the aluminium, iron and silica into a very strong acid and then, as the material floats in the acid, change the pH rapidly so that one of the materials – silica – falls out. Once the silica is out, the deadly combination of aluminium, silica and iron that ultimately forms ‘red mud’ is eliminated. “The first thing that will come out is alumina and then the iron in an oxide form,” said Boudreault.

But what about existing red mud ponds where the threesome has already joined forces to form red mud? “Our process can separate these three elements even after they have merged, and at the same time extract alumina and other by-products, says Boudreault.

He claims that Orbite’s new process eliminates red mud. “There’s no problem anymore because essentially you don’t have this marriage of the three elements and that’s how complex it is,” he said.

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Boudreault is naturally excited about the possibilities for his new process. “What we expect is that the industry – and this is happening already – will come to us and say ‘I have a big red mud pond and I would like to transform it into these products’. And because our process can work with any type of raw material – it can work with bauxite or clay – it can work with red mud and we’re turning it into alumina,” he said.

There is no red mud left over after the process, says Boudreault, and what’s more, the Orbite process transforms red mud into alumina at a lower cost than the Bayer process transforms bauxite into alumina.

“Bayer only creates the red mud, it can’t remediate it,” says Boudreault. With the Orbite process, the alumina recovered is negative cost if the rest of the materials recovered, including the rare earths, are taken into account.
“We’re in the five percentile of the industry curve, according to CRU, so we’re the low-cost producer and with the other material, we’re not even on the same scale as anybody else,” he said.

Boudreault says the new technology can replace Bayer as an alumina refining process or, if capital expenditure is an issue and operators simply wish to solve a red mud problem, then a smaller plant with a one-to-two-year payback is available.

“We can deal with all the bad bauxite in the world so the Russians, the Chinese and everybody would have a process that would produce very low-cost alumina. Our process will break the bond between the alumina, the silicon and the iron before it creates red mud,” said Boudreault.

With such a ground-breaking process, it’s no surprise to hear that others have attempted to develop it – and failed. “They’re having a hard time right now figuring out how we remove the hematite from the alumina and a few have tried in the past. Pechiney tried it in the 1970s, but the acid ate away at their equipment and they didn’t get the separation techniques right. They were able to get something, but it was not efficient because they had to change a lot of the equipment a lot of the time.

“Now we have glass lining in the equipment, which solved the entire technological problem. The other technology that needed to be perfected was computer control of PH levels in the material. That has allowed us to make this thing possible. The separation techniques themselves are essentially well-developed liquid extraction that didn’t exist 20 years ago, but now it’s used everywhere,” Boudreault explained.

There are three key elements that has enabled Orbite’s new process to work:-
• Glass lining for the equipment
• Advanced liquid extraction techniques enabling ease of separation (of the materials).

Some of the rare earths that can be extracted using the Orbite process

Bauxite supply issues?
While traditional mining companies in Canada are sceptical about Orbite’s new process, operators with bauxite supply issues in Russia, China and India are showing a lot of interest. An agreement has been signed with Rusal, for example, and Orbite is chasing other big producers.

Orbite will have its first high purity alumina plant operational in Q1 2013 in Cap-Chat, Quebec. The alumina will be used to make substrates for LED lights.

CRU claims that between 1-2Mt/yr of new alumina capacity needs to be developed to meet demand.

“Ours is the best option both economically and ecologically,” claims Boudreault.

There are three billion tonnes of red mud in the world, he says, and 200Mt are produced annually. “It’s all there for a lifelong duration because, up until now, nobody has a process to recover the material from the red mud.”

Boudreault compares Bayer and Orbite technology with a 140-year-old woman and a 15-year-old boy, asking who would win a 50m race. “The aluminium industry is using a technology that was developed before the car existed and has hardly changed in that time,” he said.

“What’s the downfall of our technology? I’m not sure. It requires electricity, just like Bayer, but it’s less polluting and less expensive,” he said. “Our downfall is that we’re competing with a 140-year-old technology.”

Orbite’s new process is putting pressure on mining companies around the world.

“I’d like to say we’re very nice people, but we’re competing. They produce this toxic waste, red mud, and it goes into the river. It kills animals and vegetation; it puts toxic waste, red mud, and it goes into the river. It kills animals and vegetation; it puts a lot of heavy metal in the water. This is no fun. I’m leaving this place to my children.”

Boudreault quotes German philosopher Arthur Schopenhauer who once said, “All truth passes through three stages. First, it is ridiculed. Second, it is violently opposed. Third, it is accepted as being self-evident.”

“We’re bringing a new, clean technology to bear on something that has existed for a long time. Resistance to change is the biggest issue we have to face and right now. Where Schopenhauer is concerned, we’re between people saying it can’t be done and people accepting it as self-evident.”