The LCL&L process: A sustainable Solution for the Treatment and Recycling of Spent Potlining.

Laurent Birry¹, Stéphane Poirier² and Simon Leclerc³

1. Research scientist
2. Manager – By-product valorization and commercialization
3. Black belt – Business improvement
Rio Tinto - Aluminium
Corresponding author: Stephane.poirier@riotinto.com

Abstract

Spent potlining (SPL) is a hazardous waste produced by aluminum smelters. SPL is generated from the internal lining of aluminum electrolysis cells, constituted of carbon and refractory bricks and replaced after five to eight years in service. It is classified as a hazardous waste because of its contamination with fluorides and cyanides and its reactivity with water, generating explosive gases. Nowadays, the aluminum industry has made some progress with the SPL issue by recognizing that landfilling is no longer acceptable by most local communities. In 2008, Rio Tinto Alcan inaugurated a new plant in Jonquière (Québec) for the treatment of 80 kt of SPL annually, based on the low-caustic leaching and liming process (LCL&L) developed at Arvida Research and Development Centre in the early 1990’s. This paper describes LCL&L process, including valorization routes for its by-products and some technological challenges faced during the ramp-up of the plant to its nominal capacity.

Keywords: Spent potlining; LCL&L process; LCL&L by-product valorization.

1. Introduction

The aluminium smelting process takes place in a steel shell lined with refractory bricks and carbon cathodes. During the operation of the cells, molten fluoride salts and sodium penetrate into the carbon cathode lining and eventually into the alumina refractory lining or firebrick below. Pot failure occurs generally after five to eight years due to the thermo-mechanical stress generated within the pots, which allow attack of the iron collector bars and refractory lining by bath electrolyte or liquid aluminium. During pot shutdown, bath and liquid metal are siphoned off as much as possible. Once cooled, the remaining lining is then broken up and dug out of its steel shell. Iron and large aluminum pieces are sorted and recycled separately. The residual material is called spent potlining (SPL). Figure 1 shows the cross section of a pot. SPL is recognized as hazardous material because it contains significant concentrations of toxic and leachable constituents (cyanides and fluorides). Moreover, in contact with water, the reactive species of SPL, such as residual metallic Al, aluminium carbide and nitrides, have the potential of generating ammonia, hydrogen and methane. Hence, transportation, storage and final disposal of SPL are subject to strict environmental regulations.

Each ton of aluminium produced generates about 22 kg of SPL. Several factors can contribute to the variation in kg of SPL per ton of Al produced or to the variation in chemical composition of SPL. Electrolysis technology, pot operations, achieved lining life, and demolition/refining practices are the major factors. For example, the amount of bath and frozen aluminium that will remain inside the pot and thus in SPL depends on the dismantling procedures of the plant. The fluoride penetration inside the linings depends on the type of materials and the operation lifetime. For Rio Tinto (RT) in Québec, about 20 kt of SPL is generated per year.