Vessel Diagnosis in the Bayer Process Using Ferromagnetic Tracers

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Abstract

In the Bayer process, having a good knowledge of the residence time distribution (RTD) of thickened slurry and pulp flows can help achieve a more efficient operation, diagnose problems such as channeling and dead zones, or evaluate the effectiveness of operational parameters. A tracing procedure and apparatus was developed by Rio Tinto in partnership with the Université du Québec à Chicoutimi to monitor slurry displacement patterns. The principle of the apparatus is the detection of a solid ferromagnetic tracer by inductance coils. The RTD obtained is then analyzed with a proprietary Rio Tinto deconvolution method to understand the different flows inside the vessels. Iron powder is usually utilized as a tracer for its compatibility with bauxite residue. However, magnetite has been successfully tested as an alternative tracer since it can be used at higher temperature and higher caustic concentrations than typical Bayer washer circuit conditions. The tracing technique was validated at plant scale for the diagnosis of slurry behavior in deep thickeners, stirred tanks, and pipes.

Keywords: Residence time distribution; tracer; flow; diagnosis; ferromagnetic; tanks; pipes.

1. Introduction

In the Bayer process, a number of steps are required to allow alumina extraction such as pre-desilication, digestion, settling, clarification, thickening, mud washing circuit, slurry transport in pipes, etc. The industrial facilities used are quite large and many were constructed at a time when process conditions were different from today. Moreover, the general decrease in bauxite quality results in processing larger volumes for a consistent alumina production rate, which requires a better equipment performance. In this context, a better understanding and optimization of these process steps become crucial. Having a good knowledge of the RTD of slurry and/or thickened slurry flows can help to achieve a more efficient operation as well as diagnose channeling and dead zone problems in operating facilities, or evaluate the effectiveness of various operating parameters.

Tracers are widely used to diagnose the behavior of continuous flow chemical reactors [1-2]. In these techniques, the reactor RTD, from which many physical parameters can be computed, is obtained by measuring the tracer at the reactor outlet. Analysis of the RTD can be useful in diagnosing the reactor’s behavior. To be applicable to industrial facilities, this technique requires an easily measurable tracer that is compatible with the physical and chemical process environment. Tracing techniques have been used previously to simulate liquid flow in settlers [3-4] and thickened slurry behavior in thickeners [5]. Research on an on-line electromagnetic iron tracer detector capable of measuring RTD in industrial equipment has been published previously [6-8].

This paper presents a tracing apparatus developed by Rio Tinto in partnership with the Université du Québec à Chicoutimi [6-8]. This apparatus was used at plant scale to validate slurry behavior in the last deep thickener of the mud washing circuit, in a pre-desilication stirred