A YEAR OF OPERATION OF THE SOLID-LIQUID CALCINATION (SLC) PROCESS

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1.0 INTRODUCTION

1.1 Organics in Bayer Liquor

The presence of organics in Bayer liquor affects to some extent all the operating steps of the process. Organics in general and in particular, the humates, reduce liquor productivity and degrade hydrate and alumina quality (1, 2, and 3). There are many processes to remove or destroy organics from the liquor (4) but none offers a complete and specific solution to each Bayer plant.

1.2 Background

The difficulties in developing a suitable organics control technology led to a jointly funded effort by Alumina Española S.A. (Spain), (now Alcoa Europe), Alcan International Ltd. (Canada), Aughinish Alumina Ltd. (Ireland) and FFE Minerals A/S (Denmark). The result is the Solid-Liquid Calcination (SLC) process, a new, advanced and user-friendly method to safely destroy organic matter and causticize Bayer liquor.

The SLC process is based on the "sintering process" (5) and consists of four steps: (i) mixing of an alumina source with Bayer liquor, (ii) drying and agglomeration of the blend, (iii) calcination and (iv) sodium aluminate (clinker) dissolution.

An intensive pilot-testing programme to select and develop the best SLC process equipment began in 1992. Most of the preliminary work was carried out in a 24 tpd integrated pilot plant built at the F.L. Smith test centre at Dania, Denmark (5). In 1998, a nominal 120-tpd plant was commissioned at Alcoa Europe's refinery in San Ciprián, Spain (6).

2.0 THE SOLID-LIQUID CALCINATION (SLC) PROCESS

The SLC process for liquor burning comprises the following unit operations:

- Evaporation to concentrate spent liquor, crystallisation and filtration to form saltcake
- Mixing of feed materials to achieve stoichiometric chemical composition ((Al+Fe)/Na = 1)
- Evaporation, drying and agglomeration of the slurry into solid particles done in the Gas Suspension Dryer (GSD)

Figure 1. SLC Process Block Diagram
Calcination of the solid particles to form a sodium aluminate clinker done in the fluid bed calciner (FBC)

Cooling of the clinker

Gas cleaning to capture particulate matter

Leaching of clinker to dissolve sodium aluminate and recover valuable caustic and alumina

The process block diagram in Figure 1 shows the stages of the SLC process in the 120-tpd demonstration plant (6).

2.1 Feed Slurry Preparation

Plant liquor with a total soda concentration of 350-500 gpl measured as Na$_2$CO$_3$ is mixed with salt cake and an alumina source comprising a bauxite slurry or ESP dust to form a pumpable feed slurry. The mixing is done in an automatically controlled batch-process. The feed slurry is then pumped to the GSD via an intermediate holding tank.

2.2 Evaporation and Drying

The feed slurry is injected into the GSD through atomising spray nozzles. The GSD is operated at an inlet temperature minimising emission of volatile organic matter, and at an outlet temperature providing complete evaporation of water without scaling. The dry product is discharged from the bottom of the GSD in the form of granules or pellets.

2.3 Calcination

The dry material is calcined in a fluid-bed. The calcination unit provides sufficient residence time at 900-1000°C for complete destruction of organics and formation of sodium aluminate. Slightly higher temperatures are needed if ESP dust is used as the alumina source.

2.4 Cooling

Cooling is performed in a controlled flow grate cooler, designed for cooling the solids to about 80°C, which is desirable for leaching the clinker with plant liquor.

2.5 Gas Cleaning

Dust emerging from the calcination and cooling units flows with the hot gases into the GSD where it is re-agglomerated into the dry product. The fine fractions of the dry solid are entrained out of the GSD by the gas flow and captured in a baghouse and recycled directly into the GSD, thus reducing the overall dust emission to below environmental standards.

2.6 Leaching

The cooled sodium-aluminate clinker is discharged into the dissolution tank and recycled back into the Bayer process dissolved in plant liquor.

3.0 PERFORMANCE AND EXPERIENCE OF THE SLC DEMONSTRATION UNIT

The nominal 120-tpd clinker demonstration unit was started at San Ciprián in the autumn of 1998. Success of this unit was to be determined by achievement of the criteria set out in Table I.

After almost 10 months of operation of the plant we are now in a position to make an assessment of the performance of the plant as well as to check our design.

<table>
<thead>
<tr>
<th>Performance Parameter</th>
<th>Success Criteria</th>
<th>Remarks</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Availability</td>
<td>&gt;85% of available time</td>
<td>During 30 days out of first six (6) months</td>
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<tr>
<td>Organics destruction</td>
<td>&gt;95%</td>
<td></td>
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<tr>
<td>Dust emission</td>
<td>&lt;50 mg/m$^3$ (dry, 11% O$_2$)</td>
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<td>TOC emission</td>
<td>Odour free</td>
<td>150 ppm at 11% O$_2$</td>
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<tr>
<td>Recovery of Na &amp; Al</td>
<td>R$<em>{Na^+}$R$</em>{Al^3+}$&gt;0.85</td>
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<tr>
<td>Capacity</td>
<td>1) Consuming all salt cake produced during the commissioning period 2) 80 tpd Clinker</td>
<td>30 days period</td>
<td></td>
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<tr>
<td>Specific heat consumption</td>
<td>2025 kcal/kg Clinker</td>
<td></td>
<td></td>
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<tr>
<td>Specific power consumption</td>
<td>170 kWh/t Clinker</td>
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</tbody>
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3.1 Availability

This was achieved during March 99. In general, following the commissioning of a new plant, there is a period of learning for the operations and maintenance staff when the responsibility for the plant changes over from the commissioning team to the regular staff. During this period availability of the plant normally decreases for some time before rising back to a steady level.

3.2 Organics Destruction

This has been consistently achieved. Although the organics content in the feed slurry can vary depending on the amounts of saltcake and spent liquor used in the mixture, the TOC in the final product is on average less than 0.1%.