Transformation of a Dual Stream Low Temperature Digestion Facility

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Abstract

Refineries processing primarily Gibbsitic bauxites require a low temperature digestion circuit to extract the alumina. These circuits typically operate at between 145 °C and 150 °C. Since the 1960's, many of the world's low temperature digestion facilities operated as dual stream circuits with the caustic liquor heated progressively through shell and tube heaters using regenerative flash steam. The liquor and bauxite streams were then mixed at the autoclave or digester vessels. With increasing focus on maximizing energy efficiency, process simplicity and plant utilization, single stream digestion technology has been increasingly the technology selected for refineries around the world. The single stream digestion flowsheet preferentially combines the bauxite and caustic liquor streams together in a single stream prior to regenerative heating. This paper provides a brief overview of the considerations required for the transformation of a dual stream low temperature digestion facility to a single stream operation. A review of process performance parameters and design considerations will be discussed.

Keywords: low temperature digestion; dual stream, single stream.

1. Introduction

Alumina refineries use primarily the "Bayer" process to extract alumina from Gibbsitic, Boehmitic or Diasporic bauxites. Refineries processing Gibbsitic bauxites require a low temperature digestion circuit to extract the alumina. These circuits typically operate at between 145 °C and 150 °C.

The conventional low temperature digestion flowsheet of Figure 1 employs a "split" or "dual" stream system whereby the liquor and bauxite streams are combined at the digester or autoclave. The liquor is directed through typically three or four stages of regenerative heaters for energy recovery prior to being mixed with the bauxite slurry.

Despite the relative simplicity of the dual stream flowsheet, there has been a growing interest in the merits of the single stream flowsheet and its application to the low temperature digestion circuit. As for the high temperature digestion flowsheet, the benefits of single streaming for a refinery processing a Gibbsitic bauxite may be generally summarized as:

- it provides the best thermal match between heat source (flash tank train) and heat sink (heaters). No 'export' of recuperative flash tank energy is required,
- the endothermic heat of reaction through the heating circuit acts as a "free" heat sink, reducing recuperative heat transfer areas,
- as a result of the gibbsite dissolution towards the equilibrium A/C, the driving force for desilication reduces reducing De-Silication Product (DSP) formation on the heat transfer surfaces; this therefore reduces condenser tube cleaning frequencies,
- with gibbsite dissolution through the heating circuit, the alumina dissolution passivates the steel reducing the 'free' caustic and allowing (typically) the use of standard grades of

carbon steel for the recuperative and live steam heater materials depending on caustic concentrations,
- it potentially unlocks yield constraints without requiring exotic materials for heater tubes and wetted surfaces.

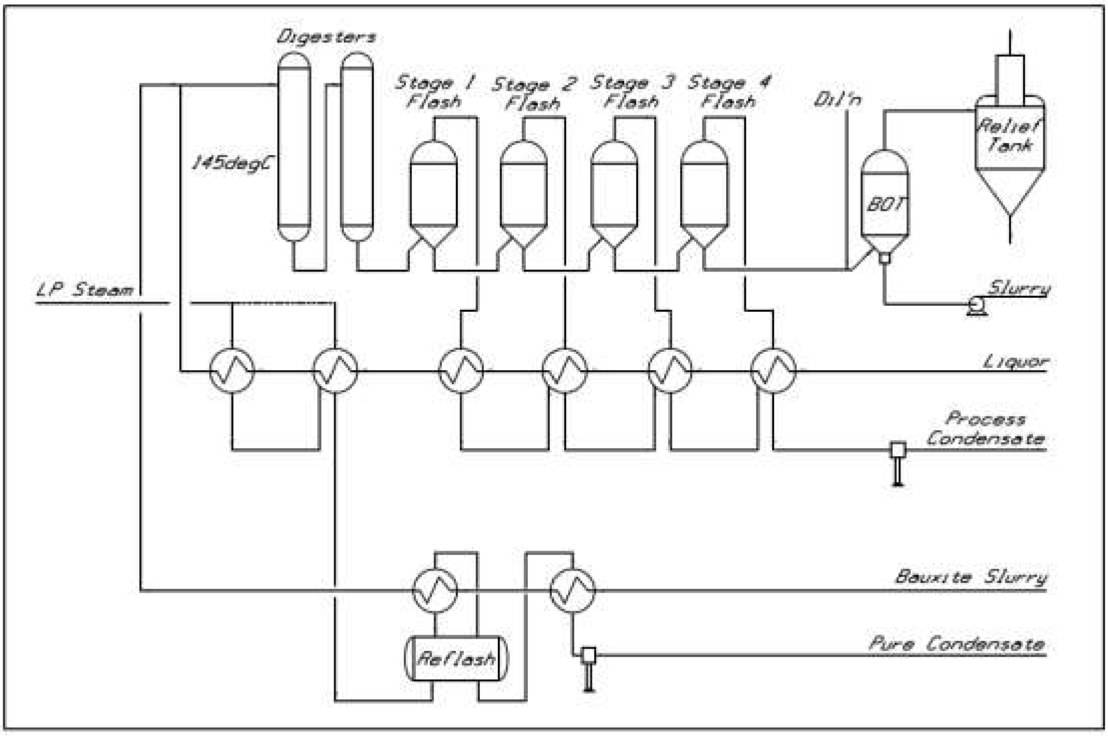

Figure 1. Dual stream low temperature digestion flowsheet.

For an existing dual stream operation to extract the benefits listed above and convert to a single stream operation, a thorough transformation process is required commencing with the mass and energy balance.

2. The Transformation Process

A flowchart of the main elements of a low temperature digestion single stream transformation process is shown in Figure 2 below. Each of the main elements of this flowchart are further discussed below.

2.1. Design Criteria

The Design Criteria defines the salient process performance targets for the new facility with key inputs that will be used in the mass and energy balance. For the single stream digestion conversion, this may include:

- the annualized refinery production target and refinery operating factor,
- the new single stream digestion facility operating factor,
- the digestion temperature and digestion energy consumption target,
- mass flows of input streams (bauxite slurry feed, liquor etc.),
- steam supply pressure and temperature at a nominated battery limit,
- chemical reactions and conversion extents, heats of reaction,
- heater stage heat losses,

2.4.2. Structural Loadings

Where new condensers are to be incorporated into existing structural buildings, the condenser weights may impart new loads on existing structures and concrete foundations. To limit plant downtime the constructability sequence may further require a staggered implementation, meaning loads from new condensers may be additive to the existing equipment during the transformation. These new loads must be checked such that the structural building and foundation integrity is not compromised.

2.4.3. Constructability

Once the scope of transformation process has been defined, the implementation process will require a construction execution plan, detailed process and utility tie-in list and detailed project schedule. Stage or sequencing P&ID's may, for example, need to be developed to accommodate certain tie-ins.

3. Conclusions

This paper outlines the salient elements of the flowsheet transformation for a low temperature dual stream digestion facility to a single stream facility, including the strategic process benefits and key design parameters. A generic transformation flowchart has been presented that outlines the major process and mechanical considerations to be assessed such that critical equipment availability is sustained and operational life is maximized.

4. Acknowledgements

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5. References

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