Management of HDPS Siphon System in AP40 Kitimat Smelter - Roadmap of Challenges and Process Optimization

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Abstract

Kitimat Aluminium Smelter uses AP40 Technology with eight sections of 48 pots in a single pot line configuration with a unique asymmetric gas treatment centre (GTC) configuration requiring a unique “siphon” alumina conveying system. The Siphon bridges the North and South Hyper Dense Phase System (HDPS) branches by transferring alumina underneath the centre passage. Siphon design posed many challenges during commissioning, start up and is still undergoing optimization. There were occasions in relation to siphon functionality leading to disruption of alumina supply to south branch of the pot room. The original design used air injection points in the south column to assist the material flow, however the nozzles experienced severe scaling phenomenon which induced operational challenges. Technical trials have made it possible to overcome this problem by installing an air injection under the fluidization fabric at the outlet of the horizontal part of the siphon. Air injection is equipped with a static flow control (SFC) which favours optimization of air flow and pressure within the siphon. Balancing the HDPS through multiple measurements and finetuning the operational set points in conjunction with rigorous checks and balances has greatly improved the reliability and operation efficiency of the siphon system.

Keywords: Hyper dense phase system (HDPS), Siphon, Alumina supply disruption, Static flow control (SFC).

1. Introduction

The Hyper Dense Phase System (HDPS) is a specialized alumina distribution system used in aluminum smelting operations to efficiently move alumina powder across long distances horizontally, without relying heavily on mechanical conveyors [1]. The system is particularly advantageous for facilities where space constraints, building layouts, or energy efficiency drive the need for non-mechanical material transport solutions.

1.1 Kitimat Design

In the Kitimat smelter layout, the decision to place only one Gas Treatment Centre (GTC) per four sections introduced a new set of logistical constraints. Specifically, alumina needed to be transported from silos located in the north courtyard to pots in the south courtyard, with a central passage and other infrastructure bisecting the site. To address this, a siphon-based HDPS was developed to vertically route the alumina from one side of the central passage to the other.

Kitimat has 384 pots operating at 405 to 415 kA, requiring between 95–97 t/h of alumina, meaning 48 tonnes of alumina is transported through the four siphons every hour. When supplying half of the potline through the siphons there is an increased risk. For example, if one siphon system fails, there is a total of 18 hours of alumina autonomy available to fix the issue before putting 48 pots in “sleeping mode” or stopping their operation. While innovative, this siphon design presented unique engineering, operational, and safety challenges, which Kitimat was able to manage through innovative problem solving and future planning.

Figure 1 shows the cross section of the Siphon System, Figures 2–6 Show the material flow from the North HDPS branch to the 6.5-meter descent to the siphon, the 6.5-meter accent to the South HDPS branch and a 300-meter stretch of HDPS on the South branch. Arrows in these Figures indicate the alumina flow.

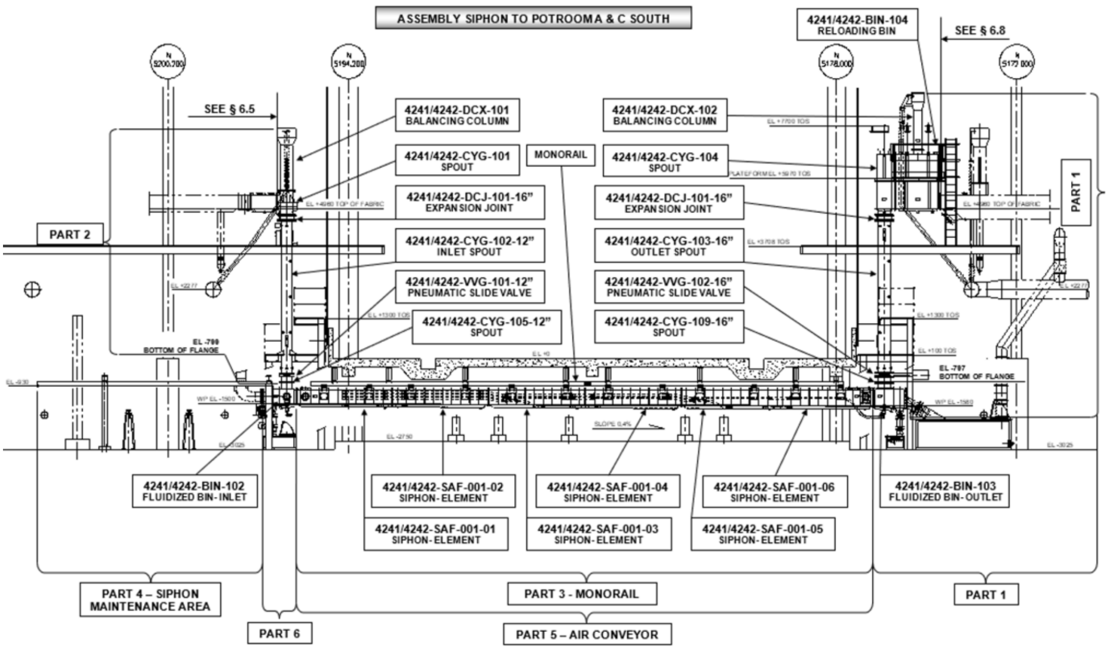

Figure 1. Cross section of the siphon system.

6. Conclusions

Operating a unique HDPS with an integrated vertical siphon poses significant technical and operational challenges. However, through continuous optimization of the system's pressure regulation, air delivery, structural integrity, and material flow paths, the siphon system has evolved into a highly functional and efficient solution. With further refinement, it stands as a pioneering example for how future smelters might adopt similar systems in constrained or non-traditional layouts. The lessons learned here may set the groundwork for innovation in alumina transport and plant design in the years to come.

References

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