Economic Simulation-based Decision Support for Cathode Re-lining Facility

J. Caissy[1], Shawqi Al-Hashimi[2] L. Tikasz[3], R.I. McCulloch[4]
1. Reduction Specialist
3. Modeler
4. Center of Excellence Manager
Bechtel Canada Co, Montreal, Quebec, Canada
2. Project Director
Aluminium Bahrain B.S.C., Kingdom of Bahrain
Corresponding author: jcaissy@bechtel.com

Abstract

Within Bechtel Mining & Metals, the Technology Center tests and validates design alternatives and operational variants including economic analysis. During the Front-end Engineering and Design (FEED) for the new Alba Potline 6 Project a study was done for a new cathode re-lining facility with limited available space for the new re-lining facility. The first generation of pots would fail following a Weibull distribution curve. Waiting for the pots natural end of life would involve a very high peak re-lining rate and therefore a high capital cost re-lining facility. Most new smelters prefer to have the pot out of service before the end of their predicted life to reduce the peak re-lining rate and therefore reducing the necessary capital cost. Using a dynamic model combined with a lifecycle cost analysis, it is now possible to generate a curve to determine the optimum lifecycle cost considering operating and capital cost for a series of different peak pot re-lining rates. The now available "economic-process" model would be well parameterized, adaptable to other plants and would provide the benefit of a more controlled program for various pot failure scenarios.

Keywords: Alba Potline 6 cathode relining facility; pot failure statistical distribution; Weibull distribution; lifecycle cost analysis.

1. Introduction

The Alba Potline 6 Project would be located in the existing Alba Smelter boundary in the Kingdom of Bahrain. The project scope includes the construction of a 6th Potline utilizing Dubai Aluminium (DUBAL) DX+ULTRA reduction technology consisting of two (2) potrooms with a total of 424 pots and associated Carbon Plant, Cast House and Infrastructure facilities.

Bechtel has been engaged by Alba to prepare a FEED study for the the Alba Potline 6. A new lining and de-lining facility is part of the FEED. The new Potline 6 Project would have limited available space requiring, the new re-lining and de-lining facility design to be located in the available space between the two potrooms. The design of the re-lining process has been based upon operating 52 weeks per year, seven days per week and 24 hours per day.

In determining the design and configuration of the new facilities for a series of different re-lining rates per year, several key questions arose including:

- How many potshell cooling stations would be required?
- How many de-lining pits and lining stations would be required?
- Should potshell repair be done in-house or by an outside contractor?
- What would be the risk associated with different scenarios?

The typical method used to answer these questions would be to create a static, sequential schedule with estimated time to accomplish different operations within an assumed operating and maintenance schedule.

For the first cathode re-lining cycle in a new smelter all the pots require re-lining within a short time period. Therefore, the cathode re-lining facility needs to be capable of sustaining the initial peak of pot failure.

The static model was run several times to determine the number of the following stations required for each scenario:

- Cooling stations
- Transfer pits
- De-lining pits
- Lining stations

The static model was run with an in-line lining de-lining arrangement. Due to the limited space available between the potrooms adjacent to the central passageway it was determined that a second lining de-lining building would be required, located between the potrooms at the non-rectifier end of the potrooms.

To validate the Alba Potline 6 scenarios a discrete event model (DEM) was developed by Bechtel. The DEM is an ideal platform to simulate dynamically the cathode re-lining process. The DEM provided flexibility for the user to explore and rapidly test different numbers of lining stations, de-lining pits, operating schedule variants, cathode cooling time, maintenance shift requirements, breakdown frequency and other multiple iterations. Once configured the DEM provides an ideal tool to rapidly test multiple scenarios.

While developing the model, Dubal provided the tentative cycle time for each of the operations, The model created an opportunity to review the re-lining operation in terms of cooling stations, lining stations, de-lining pits, shell repair stations, transfer pit, equipment and tools. This is an optimized approach to the design the cathode re-lining facility.

The purpose of the DEM was to provide an optimum facility configuration for each of the different pot re-lining rate scenarios.

After completion of the DEM model runs, an economic study has been performed considering the Capital Expenditure (CAPEX) and Operating Expenditure (OPEX) for each configuration. The new lining facility would re-use the equipment required for construction of Alba Potline 6, therefore the equipment cost was considered to be zero. However, as the de-lining shop would be new, all associated cost for the new de-lining equipment have been included.

Re-lining rate scenarios were analyzed from 2 to 10 pots a week, however as it is not possible to add ½ a cooling or ½ a lining station, only scenarios with integer number of stations per week have been further developed.

The life cycle cost was evaluated for each scenario based on an estimated pot life of 6 years. Costs for pots that would be cut out before the end of their useful pot life have been accounted for with the loss of the residual value of the pot.

11. References

1. Laszlo Tikasz et al., Simulation-based decision support in cathode re-lining facility design, *Light Metals* 2016, 997-1002.
2. M.I. Hassan et al., Mathematical model of cooling of a stopped pot and its validation, *Light Metals* 2013, 851-855.
3. L. Tikasz et al., Moving equipment and workers to mine construction site at a logistically challenged area, *REWAS 2013 Symposium, held during the 142nd TMS Annual Meeting & Exhibition, San Antonio, Texas, 3-7 March 2013*), 111- 120.
4. L. Tikasz et al. Safe and Efficient Traffic Flow for Aluminium Smelters, *Light Metal*s 2010, 427-432.
5. K. Tschope, Ch. Schoning and T. Grande: Autopsies of spent pot linings – a revised view, *Light Metals* 2009, 1085-1090.
6. Broner Metals Solutions, Business solutions that create value for aluminium producers, *(White Paper, www.bronermetals.com, Watford, UK, 2004),* 1-6.
7. B. Shnits, J. Rubinovitz and D. Sinreich, Multicriteria dynamic scheduling for controlling a flexible manufacturing system, *International Journal of Production Research,* 42 (17) (2004), 3457-3472.
8. R. Weibel et al., Ageing of cathode refractory materials in aluminium reduction pots, Light Metals 2002, Pages not assigned in the book.