

Research Programs

Optimization of Molybdenum Electrodes for Glass Melting Furnace

Research Team:

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Introduction

The U.S. glass industry is a \$28 billion enterprise and millions of tons of glass are melted each day by different heating techniques. This study will focus on electric heating with molybdenum electrodes (shown in Figure 1), generally referred to as GME – glass melting electrodes. The utilization of electrical heating is bound to rise steadily because it is cleaner and more energy efficient. However, Mo electrodes suffer attack from molten glass and fail prematurely. Due to the redox reactions, the life of Mo electrodes is limited. Moreover, during the charge, and while the glass is not yet molten, the Mo electrode is exposed to the ambient and thus oxidizes leading to failure. Glass manufacturers have suggested the need for better performance of Mo electrodes will result in rapid advancements in the use of electric heating systems in the glass industry. Recent advances have utilized coating or micro-alloying techniques into Mo electrode production in order to extend its service life and improve its endurance during use.

It can be noted that the need for enhanced and improved Mo electrodes for glass melting is a real need, and that it has significant economic implications. This study was launched to establish the operative mechanism(s) leading to degradation and failure of Mo electrodes when in use with different molten glass chemistries, and develop solution pathways to optimize Mo electrodes.

Objectives

- Establish operative failure modes and mechanisms in Mo electrodes.
- Develop solution pathways to optimize GME life and mitigate failure.

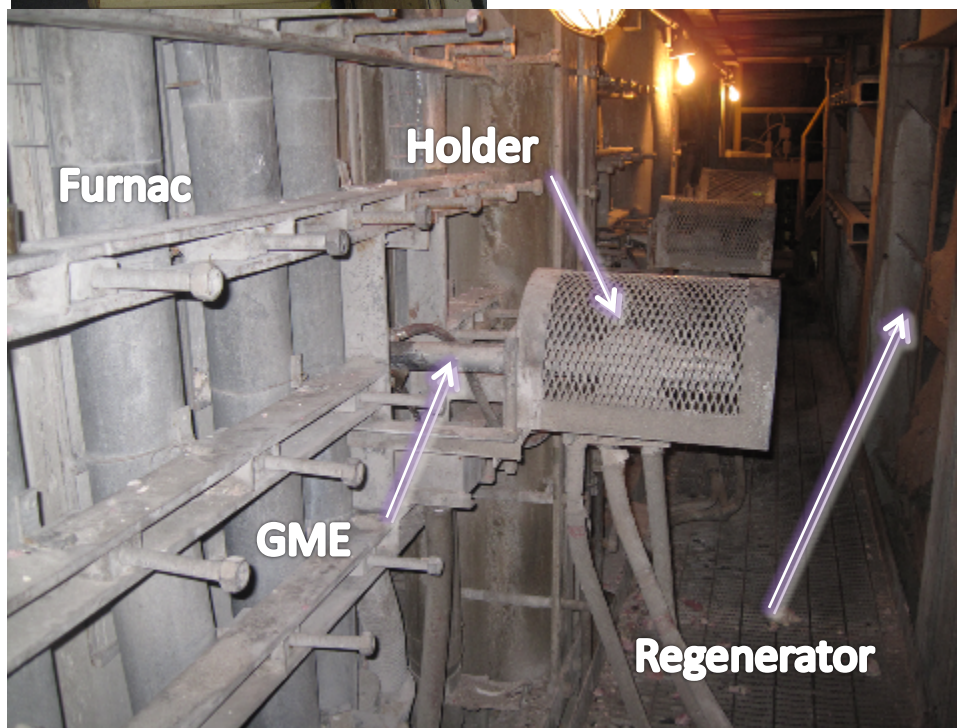
Methodology

The objectives listed above will be achieved through three project phases:

- Phase 1 focus is on the analysis for used electrodes from the commercial sector to carry out post-mortem analysis of failed electrodes and develop hypotheses for failure modes and mechanisms in glass melting electrodes.
- Phase 2 is aimed at the design of the borosilicide coating for Mo electrode to improve its oxidation resistance.
- Phase 3 is the beta site testing of differently processed Mo electrodes in different glass chemistry environments, and their failure modes will be analyzed and studied. In essence this phase will be the validation phase of the concepts we have developed and brought from the laboratory to the actual commercial setting.

Deliverables

- Mechanistic understanding of failure mechanism of GMEs for glass industry.
- Validation of solution pathways to alleviate failure and to extend GME life through experimentation.
- Based on above, introduce to the market an optimum GME that is far superior to existing alternatives; develop an optimum GME as a function of glass chemistry.



(a)
Fig 1: (a) Single piece glass melt electrode (GME).

(b)

(b) Electric heating furnace with Mo electrodes.