Title: Innovative Regenerator Design: Synergistic Integration of TIP, TLW, TGW, and LCP Refractory Solutions for Enhanced Glass Furnace Efficiency and Sustainability

Introduction

As the glass industry faces mounting pressure to reduce energy consumption and emissions, the regenerator remains a critical component for thermal efficiency. Traditional "one-sizefits-all" designs often lead to suboptimal heat transfer and premature failure. We present the INNOREG (Innovative Regenerator) concept by RHI Magnesita—a comprehensive toolbox utilizing the proprietary R21 Thermal Model. INNOREG engineers tailor-made layering and grading configurations by analyzing specific customer inputs, including flue gas temperatures, reversal times, and corrosion potentials. **Core Technological Innovations: TIP, TGW, TLW, and LCP**

- TGW: Deployed in the upper condensation and hot zones, TGW bricks feature a specialized $MgO\text{-}ZrO_2\text{-}SiO_2$ matrix. This chemistry provides exceptional thermal conductivity, allowing the checker work to rapidly absorb waste heat and release it to the combustion air, drastically reducing fuel requirements.

- TLW: The cornerstone of the INNOREG hot zone design, TLW bricks maximize thermal efficiency. Featuring a unique "mouse hole" chimney design, it significantly increases the Specific Heat Exchange Area (SHTA) and enhances turbulent gas flow. This ensures homogeneous temperature distribution across the regenerator cross-section, eliminating cold spots and maximizing heat absorption.

- LCP: Radiant heat loss through the regenerator casing severely impacts efficiency. The INNOREG concept integrates LCP solutions—specialized insulation panels and brick shapes designed to minimize external surface temperatures. Furthermore, LCP geometries provide a larger flue cross-sectional area, actively reducing the risk of clogging from sodium sulfate and batch carryover.

- TIP: Beyond material science, INNOREG's TIP strategy focuses on operational excellence. By optimizing checker configurations and flue sizes, TIP minimizes air infiltration and simplifies mechanical cleaning. This proactive design approach prevents condensation related blockages, ensuring the regenerator operates at peak efficiency throughout the entire campaign.

Proven Results and Sustainability Impact

Real-world case studies demonstrate the profound impact of the INNOREG strategy. By implementing a TLW-based configuration (swapping traditional TG shapes for TLW150 in the hot zone), a standard 450 tpd furnace achieved a regenerator efficiency increase from 88.5% to 91.0%. This optimization translates to a saving of 227,760 Nm^3 of natural gas annually, equivalent to a reduction of 447 tonnes of CO_2 emissions per year, and free € 115,900 savings on CO_2 taxation.

Keywords: *INNOREG, Glass Furnace Regenerator, TLW, TGW, LCP, TIP, Refractory Engineering, Energy Efficiency.*