

THERMO-MECHANICAL ANALYSIS OF A REFRACTORY FAILURE – ROOT CAUSE ANALYSIS

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ABSTRACT

Following the failure of a monolithic refractory in a furnace, a detailed root-cause analysis has been performed. The motivation of the analysis was to assess the possible reasons and mechanisms of failure and take appropriate preventive steps to minimize the possibility of future failure. A high-fidelity finite element model was build based on the available drawings and field inspections and a thermo-mechanical analysis has been performed to estimate the stress at various points of the refractory. The monolithic refractory was supported by a steel casing at the back, which was found to interact with the monolithic refractory. The analysis revealed the following possible causes for failure : a) the temperature of the steel plate was unevenly distributed, thus leading to geometric distortion and excessive stresses at the points of connection with the refractory; b) the refractory, being monolithic, does not allow for large thermal deformation, whereas the steel back plate was undergoing large thermal deformation due to excessive conduction heat transfer from the refractory; c) Not enough annular gap was provided at the connecting point between the steel casing and the refractory. The analysis was able to predict the locations of the failure fairly accurately. A brick-and-mortar type refractory was also analysed as an alternative for replacement. It was found that after a few design tweaks, the new configuration has stresses within a more acceptable level and it was approved as a suitable replacement. This facility is currently running with this new refractory without further failure.