Executive Summary

This project sought to solve the problem of slag formation on the bottom of sagger cans during the baking process of graphite electrodes for GrafTech International. The current solution for this problem involves dropping the sagger cans onto a steel plate. This causes damage to the cans and costs the company approximately $750,000 per year in repairs. To solve this, the team first needed to characterize the slag material through a series of tests including X-ray diffraction, energy dispersive spectroscopy, Fourier transforms infrared spectroscopy, and thermogravimetric analysis. The results of these tests revealed the slag to contain primarily silicon and oxygen with no binder phase present. Following the material characterization, both pre- and post-bake chemical solutions were explored. Pre-bake solutions that were examined included organically based lubricants and solvents, polar aprotic solvents, and water-based graphite lubricants. After research, none of these were deemed to be viable options due to the furnace environment and environmental regulations. Changing the pitch content in the mold itself was also tested but yielded negligible results. Post-bake solutions that were scrutinized included using ionic liquids as a tar and bitumen solvent as well as non-explosive demolition agents. Neither of these proved to be viable due to lack of porosity and thickness of slag. It was concluded that there is no current chemical on the market that will provide a reasonable solution to this problem. Mechanical solutions were examined next. Impact simulations were performed and accurately predicted the locations and forces where damage occurred. Using these values as well as the literature yield stress for stainless steel-304, a prototype was designed to remove the slag by slamming the bottom of the can to induce a large stress on the slag without inducing a large stress on the sagger can. While finishing the design on this prototype, the team found a product called the THUNDERBOLT 250. This provided similar action and was already on the market. The focus then shifted to designing a moil for this product that was tailored for GrafTech’s application. The team performed a cost analysis which showed the THUNDERBOLT 250 saving GrafTech $2 million over a five year period. This savings was determined using a non-automated solution and a discount rate of 15%. The team also recommended the implementation of an in-plant tracking system, as well as automation of the cleaning process. Automation alone could increase savings to $3 million over five years. The cost analysis shows that it would be beneficial to GrafTech to implement our designed moil and proposed solution to clean their sagger cans.