Developing Data Driven Tools to Enable Rationally Designed Steel Casting Alloy Production

Abstract
Steel is the most recycled material in the world and two thirds of the steel tonnage produced in the U.S. is made from scrap. Using scrap to produce a range of alloys requires the ability to formulate the composition from the scrap and other materials at hand. Using scrap for developing or modifying existing steel alloys for structural service in a manufacturing environment can be challenging. While great advances have been made in the science of steel metallurgy and the modeling of process and properties, these tools are not well suited to the ordinary engineering tasks for small producers. Many of these structural parts needs are met with an alloyed steel grade that is quenched and tempered. Small producers face the challenge of limited staff time and budget to solve the production requirements for formulating the steel alloys required. A method that would allow the producer or user to identify a composition and heat treatment to meet the properties is highly desirable.

This proposal is to develop data driven tools to formulate steel heat charges for the production of needed parts. This method will allow the steel producer to analyze the scrap available and formulate a furnace charge for part production. The project will also give guidance on the post processing, in particular, the heat treatment to develop the needed mechanical properties. The approach is to use the large amount of processing, composition and property data collected by the Steel Founders’ Society of America to understand and fully develop tools that include the alloy factors, such as ideal critical diameter for hardenability in heat treatment and carbon equivalent for welding supported by guidance for heat treatment. The objective of this project is to use these tools for rationally designed production of steel alloys using existing scrap. This method will allow alloy formulations to be created from materials on hand based on compositional analysis, targeting factors like the DI and CE to ensure desirable properties. The method will also be able to prescribe the parameters for heat treatment by a standard quench and temper cycles to produce parts compatible with the structures they support and with properties verified by hardness measures.

The project will:
- Use the new and extensive SFSA Database of commercial steel heats to develop new formulations of DI and CE with improved fidelity to the properties of steel alloys.
- Develop an approach using CE and DI to formulate heat charges and heat treat process to meet the tensile properties required for steel alloys.
- Demonstrate the utility and accuracy of the proposed methodology with heats produced from scrap materials of interest.