Optimum Scrap Management

Roberto R Treviño – AMI Automation

KEYWORDS: SCRAP MANAGEMENT, SCRAP HANDLING, SCRAP RECIPE CALCULATION, SCRAP BUYING, FERROALLOYS, RAW MATERIALS

SUMMARY

Being the cost of Scrap the highest cost by far in Steel Melting, there are not that many systems and tools that help manage and use the Scrap in an optimum way. In this paper we will describe the areas of opportunity around Scrap Management that helps melt a Heat at the lowest cost of Scrap possible. These areas include AI tools, the planning of the consumption as well as the acquisition of Scrap, the accurate account of Scrap movements once on site and the optimized use of the equipment moving Scrap. All these applications help on big savings for most of the current operations managing Scrap.

INTRODUCTION

Being the cost of raw materials the highest by far in an EAF steel melting facility, there aren't that many systems/tools that help manage and use it in an optimum way. The cost of raw materials can be anywhere from 50% to 75% of the total transformation cost from Scrap to Liquid Steel. This, of course, depends on the specific circumstances and operating conditions of each EAF facility. Optimizing raw materials in EAF steel production is crucial to control costs, maintain consistent quality, enhance environmental sustainability, and improve energy efficiency. Effective raw material management strategies contribute to the overall competitiveness and sustainability of EAF operations. In this paper will be discussing the opportunities that can be seized with the help of application software that will result in big savings for most of the current operations managing scrap.

DISCUSSION

The applications related to a complete Scrap Management System are the following:

- Scrap Buying Application
- Scrap Yard Management System
- Scrap Handling System
- Scrap Recipe Calculation Application

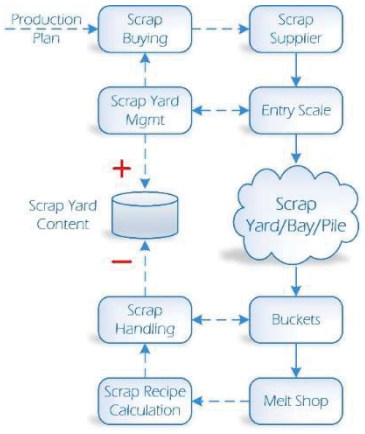

Fig. 1

SCRAP YARD MANAGEMENT & SCRAP HANDLING SYSTEMS

These are systems that every plant has and are designed to enhance operational efficiency, optimize material utilization, minimize errors, and improve overall productivity in scrap handling and preparation processes. They contribute to streamlining operations, reducing costs, and ensuring the availability of the right scrap material mix for steel production. Every plant has unique storage locations that can be categorized in two different types:

- Scrap Bay that has fixed and mobile (by railcar) scrap pile locations and the movement of scrap is done by overhead cranes.
- Scrap Yard that contains scrap pile locations spread out in the yard and scrap is moved mainly by trucks.

While these systems offer numerous benefits, they can encounter certain operational problems and opportunities. Here are some potential challenges associated with these systems:

- Data Accuracy and Integration: One common challenge is ensuring accurate data within the system. Inaccurate or outdated information regarding scrap inventory, weights, or material characteristics can lead to errors in operations and decision-making. Operator manual entry should be minimized to avoid errors in data entry.
- Sensor and Equipment Reliability: Scrap yard management systems often rely on sensors, weighing scales, and other equipment for data collection and tracking.
- System Complexity and Usability: Some scrap yard management systems can be complex and require training for operators to effectively navigate and utilize all the functionalities.
- Scalability and Adaptability: As scrap yard operations expand or undergo changes, the system needs to be scalable and adaptable to accommodate increased volumes or new processes.
- Connectivity and Network Infrastructure: Scrap yards, particularly those located in remote areas, may face connectivity challenges. Weak or unreliable network infrastructure can hinder real-time data transmission and communication with the system.
- Human Factors and Training: The effectiveness of scrap yard management systems relies on the competence and adherence of operators and personnel.

Tracking scrap movements comes down to identifying the type of scrap being moved and its weight. To be accurate in the collection of this data:

- The process to determine the scrap type should be automated through sensors avoiding as much as possible manual entry of this information.
- Scales should be calibrated often, and reading the weight should be adjusted to the characteristics of the scale (no two scales are equal).

SCRAP CHARACTERIZATION

The other two applications, the Scrap Buying application and Scrap Recipe Calculation application are two distinct applications that focus on different aspects of planning for scrap procurement and preparing the steelmaking bucket, both at the least cost possible.

In both cases, a model is developed to determine the least cost scrap mix. This model relies mainly on the characteristics of the different types of scrap (KWH/Ton, yield, density, residual content, etc.) as well as other constraints such as scrap availability, etc.

Through the utilization of AI tools, scrap characterization can be achieved by analyzing the historical data of past Heats, the composition of the charged scrap mix, and the corresponding performance and chemistry of each Heat. The frequency of conducting scrap characterization depends on the consistency of the scrap supply and its inherent characteristics. The more consistent the supply, the less frequent the need for characterization.

SCRAP RECIPE CALCULATION

Operators preparing buckets typically follow a scrap recipe to ensure the right mix of scrap for the specific steel grade being produced. This scrap recipe serves as a guideline that helps operators load a bucket with the correct layering (and amounts) of types of scrap to achieve an optimal mix for melting with the desired steel composition.

Currently, most of the EAF facilities have standard recipes for a group (family) of steel grades. The use of these standard recipes can potentially miss the opportunity to utilize cheaper scrap types when available. While standard scrap recipes provide a level of consistency and ease of operation, they may not always take advantage of cost-saving opportunities or optimize the use of available scrap.

The Scrap Recipe Calculation application focuses on calculating the optimal mix of scrap to prepare for each Heat in the Heat Lineup. This application considers the desired steel composition, scrap characteristics and availability, and their respective costs (including energy cost) to determine the most cost-effective combination. The key features of having recipes calculated per Heat instead of having standard recipes are:

- The application calculates a scrap mix recipe for each Heat in the Heat Lineup, considering the Residuals Limits specific to the Grade being produced. This calculation ensures that the resulting scrap mix is always the most cost-effective option available.
- By incorporating scrap types that already contain the necessary elements (such as Ni, Cr, Mo, etc.) the reliance on ferroalloys can be reduced at the Ladle Metallurgy Furnace (LMF). The calculation process will specifically identify and utilize scrap with the corresponding elements, effectively minimizing the cost associated with purchasing additional ferroalloys. This optimization strategy allows for cost savings by leveraging the availability of scrap materials that already possess the required alloying elements.
- The application calculates the appropriate recipe to manage grade changes, specifically in back-to-back Heats with varying residual content. The scenario that yields the greatest advantage is when a Heat with high residual content is followed by a Heat with significantly lower residual content. In such, the system optimizes the recipe calculation to capitalize on this transition, minimizing costs and maximizing efficiency.

- In Meltshops that employ continuous feeding of DRI/HBI through the furnace roof, this application will calculate the most cost-effective recipe, taking into account the available DRI for charging. The calculation considers the ratio of DRI to scrap, (25% DRI and 75% scrap or 40% DRI and 60% scrap), with the aim of minimizing costs. By optimizing the utilization of the available DRI and incorporating it into the recipe calculation, the application helps achieve the least expensive combination of materials for efficient steel production.
- In situations where a scrap type specified in the recipe is unavailable, the operator may need to substitute it with an "equivalent" scrap type while preparing the bucket. However, if the calculation takes into account the scrap inventory, there is no need to make any substitutions as the available scrap types are already considered in the calculated recipe.

This application maximizes cost savings by taking advantage of opportunities to utilize cheaper scrap types, while simultaneously optimizing the performance and chemistry of each individual Heat in steel production.

SCRAP BUYING

Given that the Scrap Recipe Calculation model operates based on predefined rules and constraints to determine the least cost recipe for each Heat, it follows that the scrap yard's inventory will be consumed accordingly, adhering to those rules and constraints. Consequently, when purchasing scrap to replenish the inventory, it is essential to apply the same rules and constraints used in the recipe calculation process. This ensures consistency and alignment between the scrap procurement strategy and the optimization rules employed in the overall steelmaking process.

This application assists the scrap buyer in determining the optimal quantities of each scrap type to be purchased, considering the current inventory and the production requirements for the upcoming month. The objective is to minimize costs while ensuring that the necessary scrap materials are available to meet the production needs.

To calculate the scrap types to be purchased, the following information is required:

- Production Requirements: The application needs the specific production requirements for the upcoming period, such as the grades to be produced and their corresponding quantities. This information guides the calculation process to determine the optimal scrap types and quantities needed to meet these production demands.
- Current Inventory Levels: The application takes into account the current inventory levels of scrap materials available in the scrap yard. By considering the existing inventory, it ensures that the purchasing calculation optimizes the procurement of scrap materials while minimizing excessive inventory or shortages.
- Parameters for Recipe Calculation: The application utilizes various parameters used in calculating recipes. This includes scrap characterization data. By incorporating these parameters, the application can accurately calculate the optimal mix of scrap materials required to meet the production requirements while considering cost-efficiency.

For the buyer to determine what scrap types to buy, an initial calculation is performed assuming an ideal scenario where all types of scrap are available in the required quantities. This calculation serves as a baseline, providing the buyer with an understanding of the scrap types and quantities to be sought. Subsequently, the buyer engages with suppliers and assesses their inventories. However, since the suppliers' scrap availability may not align with the initial expectations, a second run is conducted, incorporating the real-time information obtained from the suppliers.

This second run of the calculation determines the specific scrap types to be purchased and identifies the suppliers from whom the purchases should be made, taking into account the actual inventory information. This iterative approach ensures that the purchasing decisions are based on the most up-to-date and accurate information available.

By integrating the production requirements, current inventory levels, and relevant parameters for recipe calculation, and supplier inventory available, the application can provide precise recommendations on the scrap types and quantities to be purchased. This helps streamline the procurement process, optimize costs, and ensure the availability of the required scrap materials for efficient steel production.

SUMMARY

As mentioned earlier, a comprehensive scrap management system presents a range of cost-saving opportunities that can be capitalized upon. Here is a summary of these opportunities:

- Accurate Scrap Tracking: The precision in recording the type and weight of scrap during scrap movements is of utmost importance for systems such as the Scrap Yard Management System and the Scrap Handling System. Accurate data plays a critical role in the decision-making process associated with scrap management.
- Scrap Recipe Calculation: This calculation application seizes multiple opportunities to calculate the most cost-effective scrap recipe for each Heat in the Heat Lineup. These opportunities encompass factors such as leveraging grade's residual limits, accommodating grade changes in backto- back Heats, optimizing the scrap recipe on operations with DRI fed through the roof, minimizing reliance on ferroalloys, and more. By capitalizing on these opportunities, the application ensures efficient and cost-saving scrap utilization.
- Scrap Buying Alignment: The Scrap Buying application contributes to cost savings by aligning its rules and constraints with the recipe calculation. By following the same principles, this application ensures that scrap procurement aligns with the optimized use of scrap, further enhancing cost efficiency.

By effectively leveraging these opportunities in scrap management, organizations can streamline their operations, minimize costs, and optimize the utilization of scrap materials in the steel melting process.