Management and design of charged metal and slag in the EAF for the production of alloy steels using advanced software.

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ABSTRACT

The paper illustrates the use of advanced software for the design of the metallic charge and slag in the EAF in order to optimize the use of materials reducing direct costs, hidden costs, environmental impact.

KEYWORDS

Wollastonite, ERP, MES, SCADA, slag, scrap, LF, AOD, POWER-KI, knowledge base.

INTRODUCTION

In the past few years we have been able to monitor and check steelmaking processes in real time, thanks to new technologies.

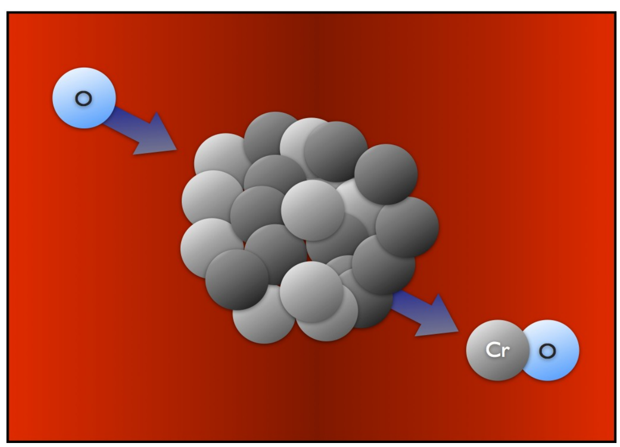
The checking of slag formation in primary processes according to the type of steel one is to produce has always been subject to often-uncontrolled customary practices.

We wish to draw attention to an example to which we have applied new software tools that have allowed us to achieve excellent results in terms of financial and investment returns, a reduction in environmental impact and increase in quality.

THE LOSS OF CHROMIUM

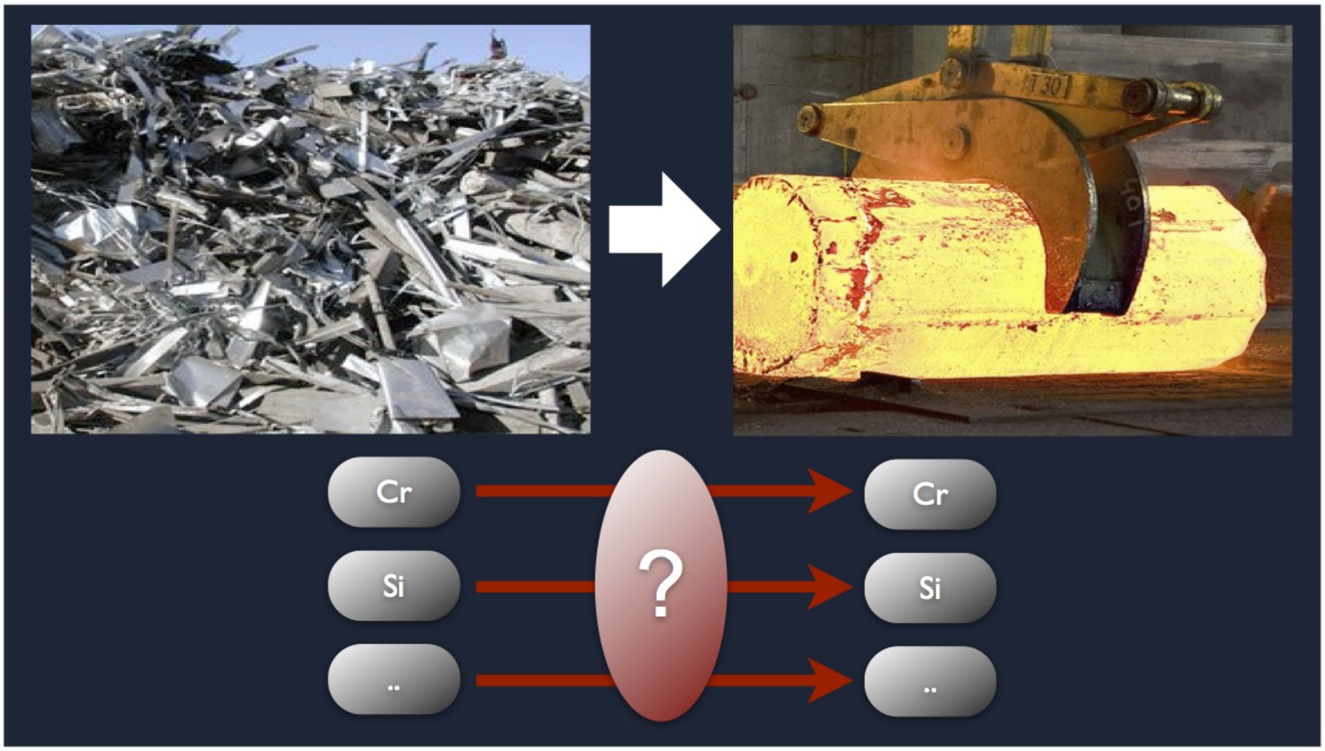
We have examined the loss of Chromium in the production of high alloy steels in Electric Arc Furnaces during the melting of the metal charge.

The loss of Chromium to oxidation in the bath is a result of the insufflation of oxygen that determines its direct passing to slag. It is possible to avoid such a phenomenon by using flux and planning the metal charge and the respective slag.



FIND THE RIGHT MIX

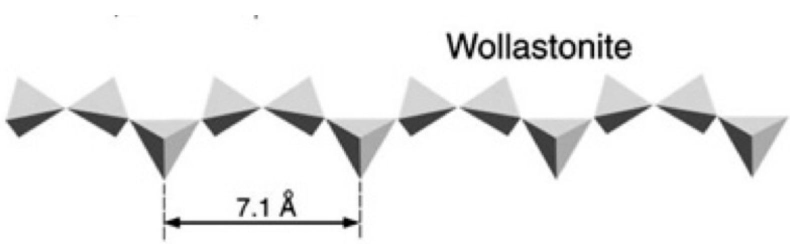
It is clear that using the same typology of scrap with the same analysis to obtain into the product entails an advantage in terms of purchase, but the actual performance depends on the variables in the process.



Finding the right combination of scrap, alloys and fluxing at the same time, simply by varying the amounts in the charge, monitoring the costs and the performances in real time, is the objective of on line control.

OnLine Control Objective
Meet Target Analysis constraint
Selection of best mix
Costs Control
Alloy performance
Real Time
Fast and easy to use

THE EXPERIMENT



In our experiments, we employed Wollastonite in grains which, combined to lime, allowed the melting point of the slag to decrease preserving the silicon and shifting the balance of the reaction in favour of non-oxidation of chromium. (See reaction below)

$CrO_{1.5(l)} + 3/4[Si]_{Fe} = [Cr]_{Fe} + 3/4SiO_{2(l)}$ ....(1)

$CrO_{(l)} + 1/2[Si]_{Fe} = [Cr]_{Fe} + 1/2SiO_{2(l)}$ ....(2)

$CrO_{x(s,l)} + xC = xCO + [Cr]$ ....(3)

The benefits have been:

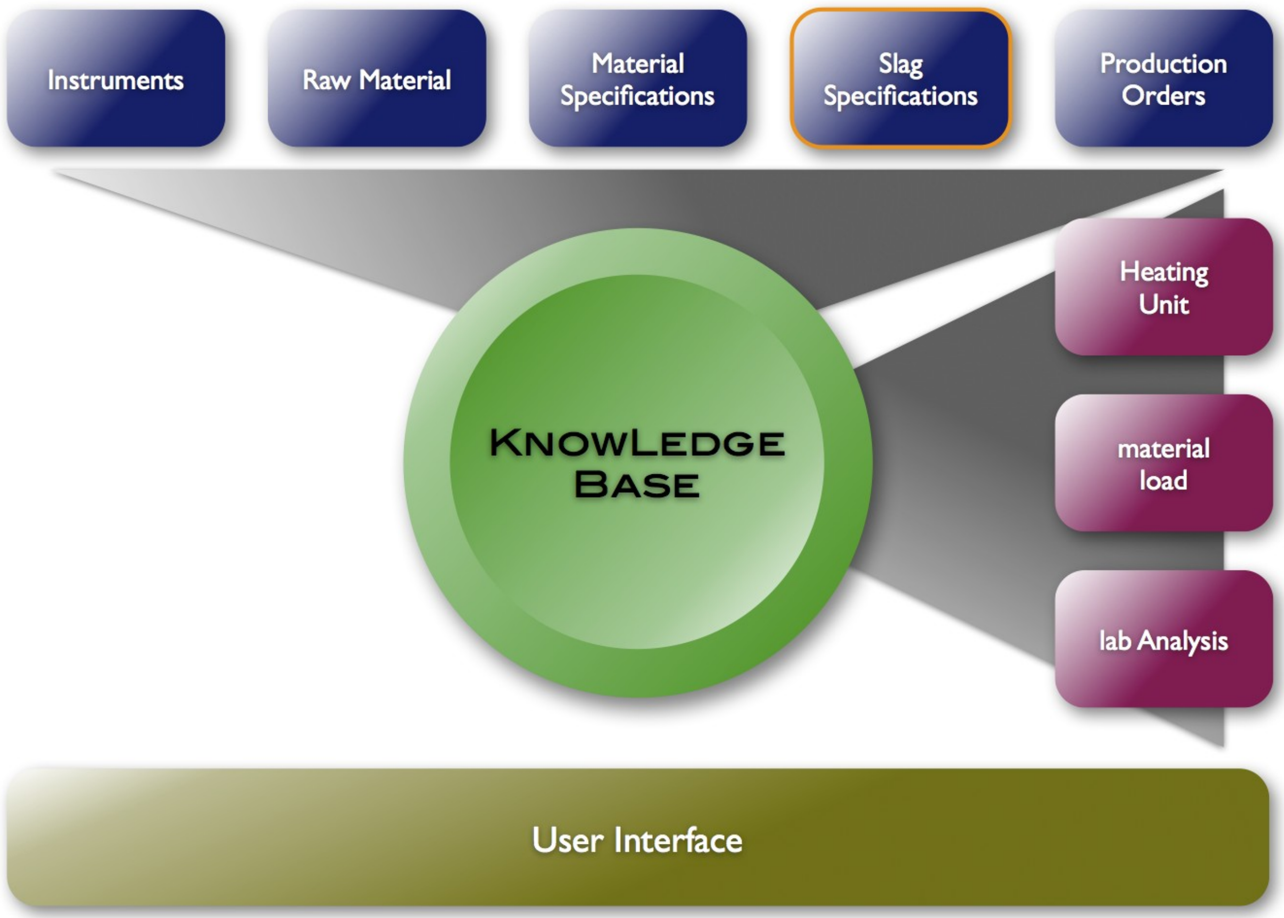
- Increase in the metal performance of chromium in the tapping and therefore a decreased addition of chromium alloys.
- A decrease in the standard of chromium in the slag and therefore less exposure to environmental risks.
- Energy conservation and the obtainment of foaming with respective benefits.
- Control of the carbon standard preserving the excessive oxidation of the bath.

THE TOOL

To carry out the experiments we have build a software suite using POWER-KI® , a new programming language for smart application, which made possible the easy implementation of many advanced features.

This tool allow the planning of the charge and of the slag. It is an application that, interfacing with the user in a dynamic and intuitive way, allows in real time during the production, adjustment of the additives that take part in the melting.

SYSTEM ARCHITECTURE

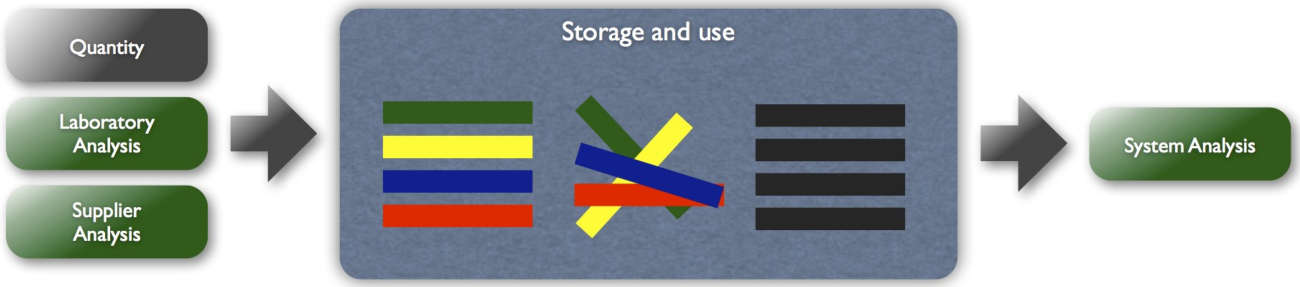


The system provides the memorisation and the management of all the information that are useful to the process, in a Knowledge Base which is itself is an improvement over the usual Data Base.

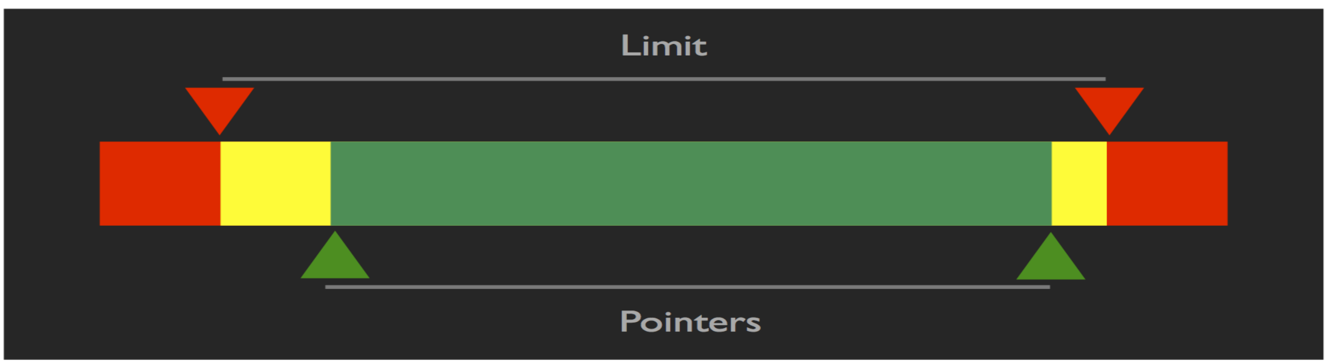
User interface is simultaneously available on all points of the plant, EAF, LF, AOD where it is necessary to make adjustment.

PRODUCTION SETUP

Analyses of the raw materials are determined, starting from those declared by the supplier and/or from laboratory observations, according to the storage characteristics: stratification , mixing, batch.

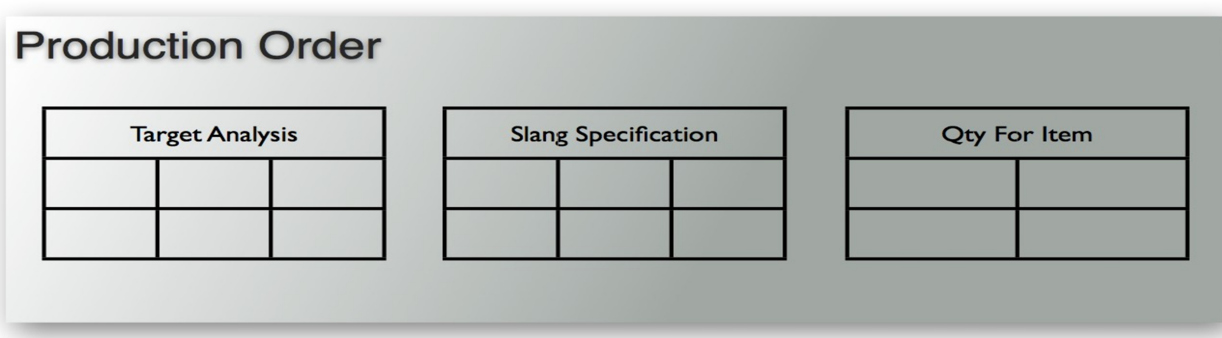


The specifications of material to be produced include the fork values required and a restrictive window (pointers) in order to meet particular technological needs. The software accepts the setting of formulas both as element values and as range values (eg `Ti>5C`).



The specifications of the slag one wants to obtain.

Orders made up of a target specification of materials to be produced, of slag specification, of quantities and of other productive information such as size, or other.

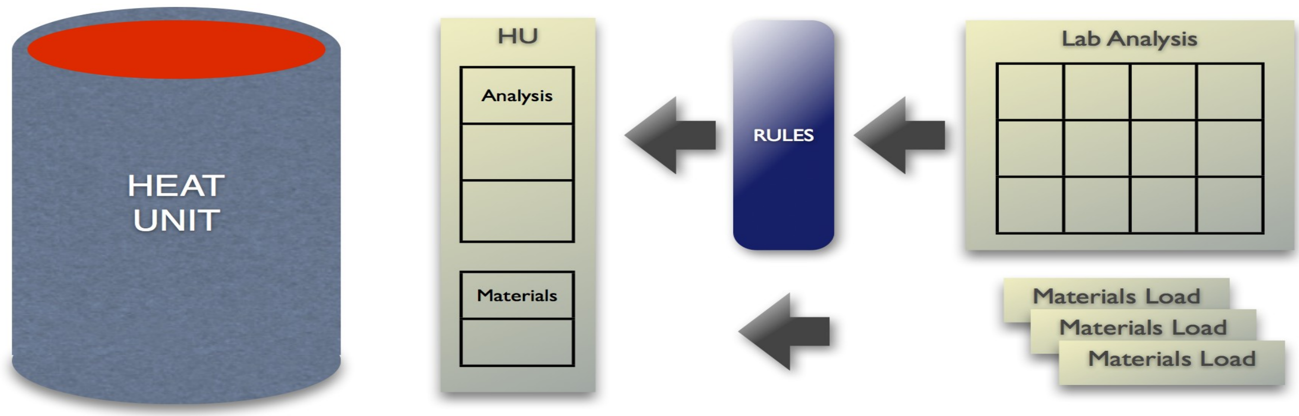


PRODUCTION PHASE

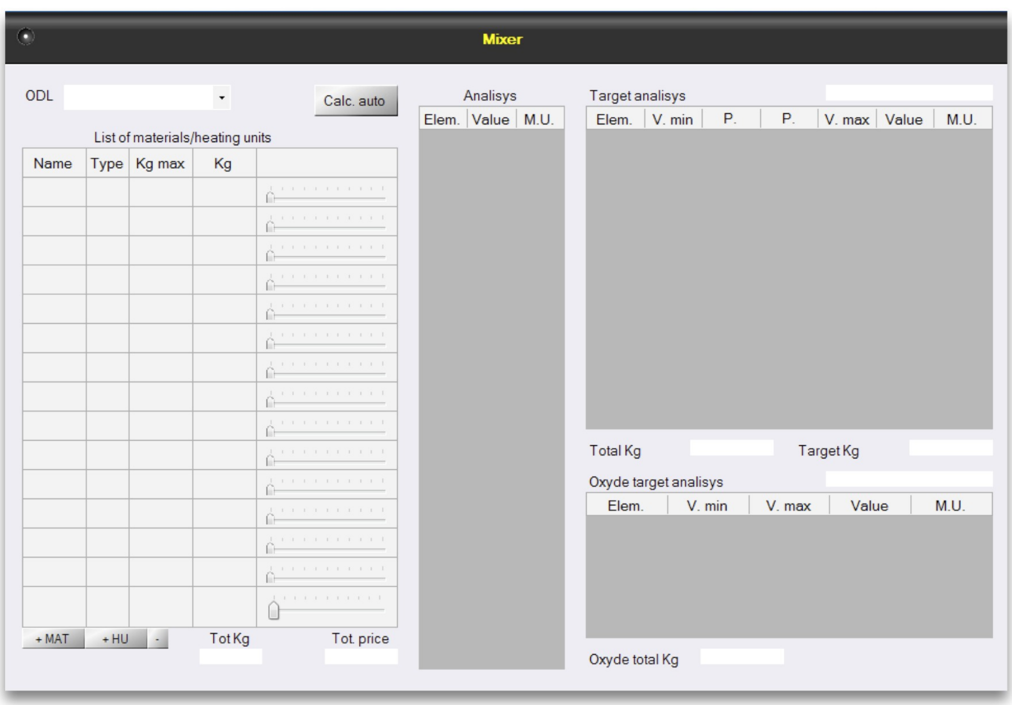
During the production, we insert the following in the Knowledge Base:

Analysis of the Heating Units, carried out with the different analytical tools at our disposal according to the rules specified for each element.

Amount of material withdrawn from the loading and the measuring out systems.



By using the software mixing tool, the operator selects the Heating Units whose analyses, together with those of the materials he wants to add, determine the expected analysis which, in real time, is compared to the material and slag specifications of the Order in process.



The software can also set the optimal additions automatically, according to the strategies defined by the user.

CONCLUSIONS

The design of the slag together with the material is an innovation in this field, in that the two systems have never been considered as bound and joined.

By employing this methodology and such advanced tools, we have succeeded in obtaining a superior metal and alloy performance with provable saving of energy.

The easy utilisation of the software allows operators to employ it immediately, eliminating most of the faults off-analysis.

Investment returns are extremely rapid, in terms of production time, better use of materials, fault elimination, energy saving and lower environmental impact.

The possibility of extending the application and the simplicity of integration to all the steel processes with programs of plant Supervision Control and Data Acquisition (SCADA) on one hand and with Enterprise Execution System (ERPs) on the other, allows the simple and economical creation of intelligent, efficient Manufacturing Execution System (MES), for environmental-friendly productive units.