FERROSILICON CHROME PRODUCTION TECHNOLOGY/PRACTICES' EFFECT ON THE QUALITY OF LOW CARBON FERROCHROME

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ABSTRACT

The discounts on the market for out of specification Low Carbon Ferrochrome are as high as 18.0% on selling price. It has become of paramount importance to ensure the conformance of the Low Carbon Ferrochrome is not compromised to keep the margins on the product in this volatile commodity market.

In the production process 90.0% of the offgrade generated is a result of carbon content being greater than 0.05% maximum required in the product.

This carbon content has an adverse effect in the stainless steel product produced.

The other 10.0% is silicon which is an in-process control. 76.0% of the carbon reporting to Low Carbon Ferrochrome comes from the reductant (Ferrosilicon Chrome) therefore the process and handling practice of ferrosilicon chrome must be such that the carbon content in Ferrosilicon Chrome remains as low as possible.

In this paper the emphasis is to ensure the % carbon from reductant is low by managing the process and handling of the reductant in both the slagless and conventional Ferrosilicon Chrome production processes.

A reduction of off grade Low Carbon Ferrochrome in terms of carbon can be reduced to less than 2.0% contribution of the overall which translates to increased revenue from the product.

1. INTRODUCTION

Low Carbon Ferrochrome (LCFeCr) is a specialized material whose production and quality must meet the stringent controls.

Carbon quality is the most vital aspect in the product as its effect on stainless quality is significant. The carbon is contributed from the various process inputs chiefly Ferrosilicon Chrome (FeSiCr) (contributing 76% of the total) and the remainder from the process slag and chrome ore used as 'coolant.'

The importance of carbon control from reductant source (FeSiCr) is a process to be subordinated to in order to achieve product quality in LCFeCr.

Cyclic Ferrochrome prices that include Low Carbon Ferrochrome on the negative side results in furnaces shutdowns for long periods.

It is of paramount importance to achieve the best quality to earn premium prices in the LCFeCr with Ferrosilicon Chrome playing a bigger role because the carbon is in the metal phase therefore it reports to the metal (LCFeCr from Ferrosilicon Chrome)

2. LOW CARBON FERROCHROME PROCESS

2.1 Process Flow

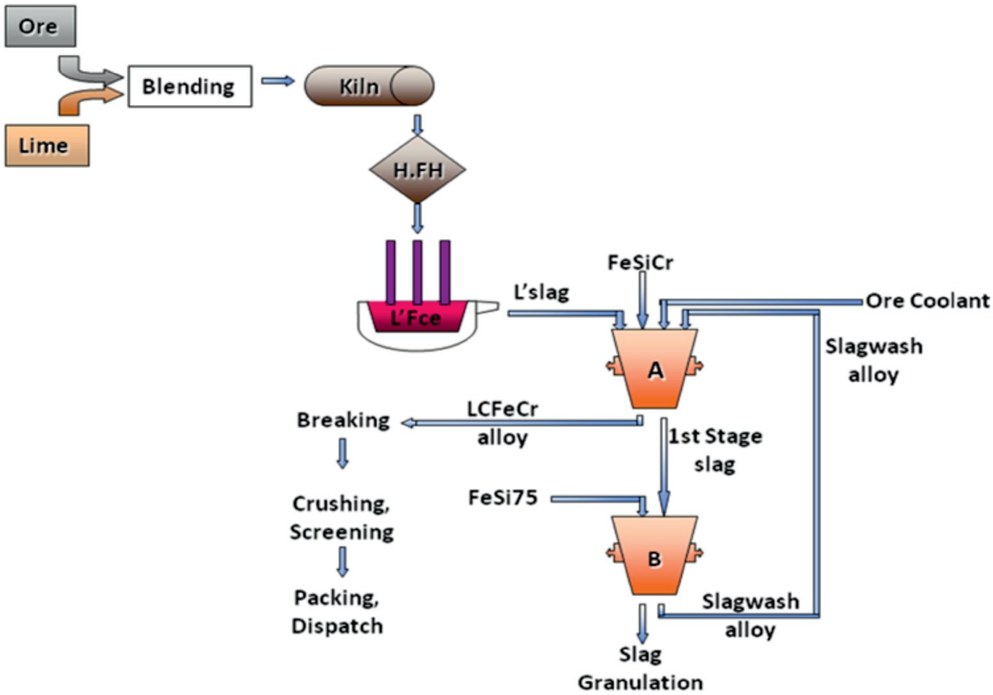

Figure 1: Detailed LCFeCr Process Flow

2.2 Carbon Source and Control in LCFeCr Process before FeSiCr Addition

The feed components lime to be precise is purchased on both carbon content and CaO as the quality specifications for process feed.

The pre-heating in the kiln is done with pulverized coal. Complete burning must take place to avoid deposition of carbon from coal on the furnace feed blend.

Materials processing that is blending, pre-heating in the kiln and melting in the furnace before the metal production is undertaken in the ladle do not have a big challenge in terms of carbon control as compared to the reductant (FeSiCr).

2.3 Carbon Contribution from LCFeCr Process Input

Input	C, %	Contribution to Total, %
Carbon from Chrome Ore Coolant	0.05639	13.3
Carbon from FeSiCr	0.3224	76.0
Carbon from FeSi75	0.01848	4.3
Carbon from Slag (out of furnace)	0.02692	6.3
Total	0.4249	**100**

A 76% carbon contribution is reported from the FeSiCr resulting in it requiring the most in carbon quality control during production and material preparation for the LCFeCr process.

The process involves the smelting in the furnace, slag and metal are tapped out together from the furnace taphole. Carbon quality control cannot be directly influenced in the furnace during smelting or feed preparation stage.

3. FeSiCr PRODUCTION PROCESS (SLAG METHOD)

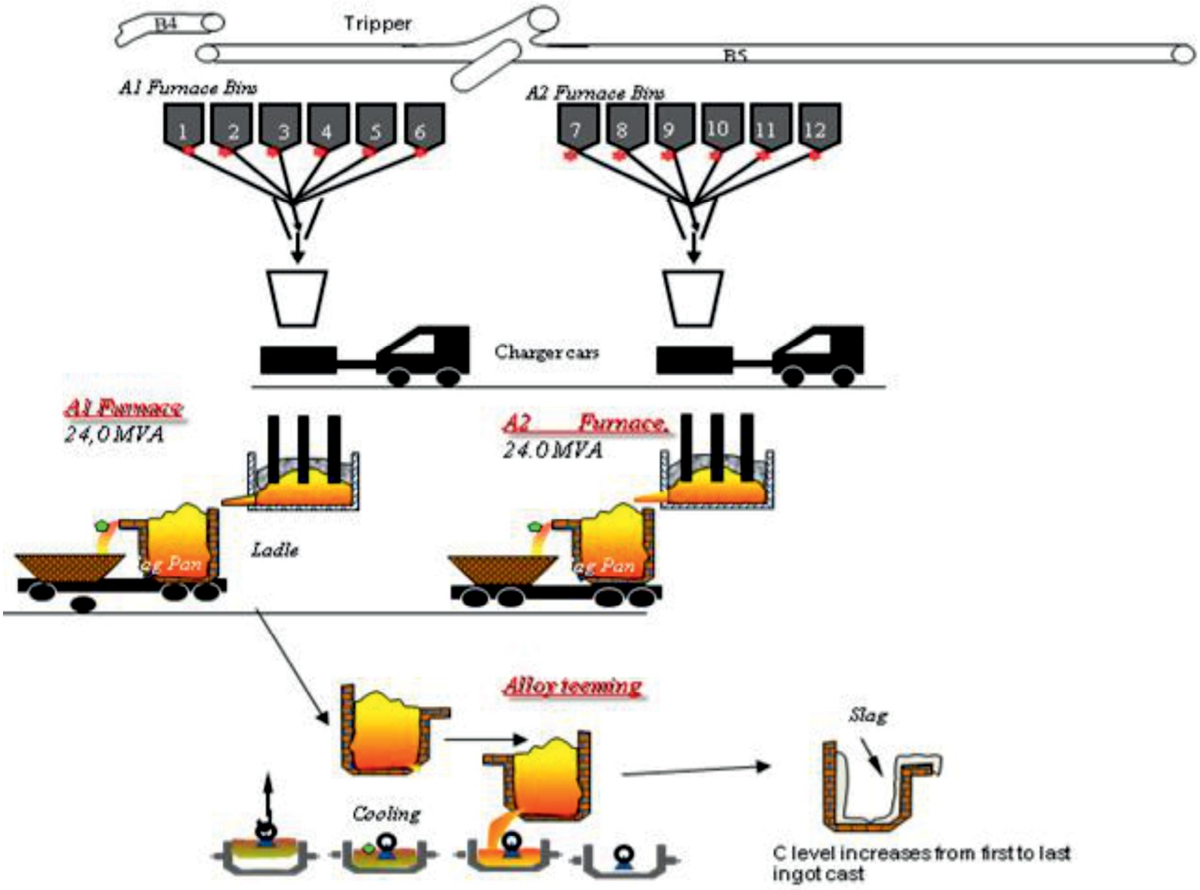

Figure 2: FeSiCr Process Flow Diagram

4. FERROSILICON CHROME CARBON CONTROL

4.1 Production Process

Ferrosilicon chrome established process give a little option of carbon control in the furnace. The silicon content in the metal has a bearing in carbon management in the ladle (outside the furnace). A relationship between the carbon in FeSiCr with silicon can be derived.

A higher level of silicon in the metal has shown to favour a low carbon content. The content of the silicon although it has a bearing on the chromium content in FeSiCr (it tends to decrese with increase in silicon content) but has a greater benefit on the carbon control while chromium content in metal generally confirms to minimum requirements without as much effort.

Metal/slag is tapped in the ladle and some slag overflowing in the slag pots. A ladle with metal/slag is a product of the taphole production. The ladle is allowed to stand for two hours with lime at the top as insulation to allow the metal/slag separation (decarbonisation process). Carbides are part of the slag that takes some carbon value with it into the slag phase.

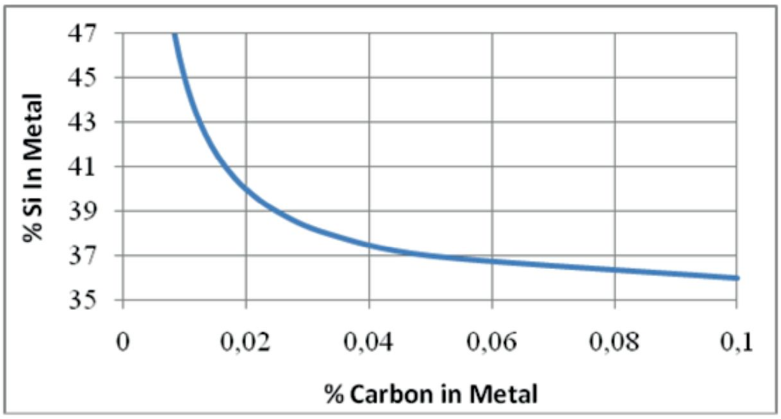

Figure 3: Relationship of Carbon Content in FeSiCr with Silicon Content

A bottom cast process in small moulds is carried out whose carbon distribution is as follows:

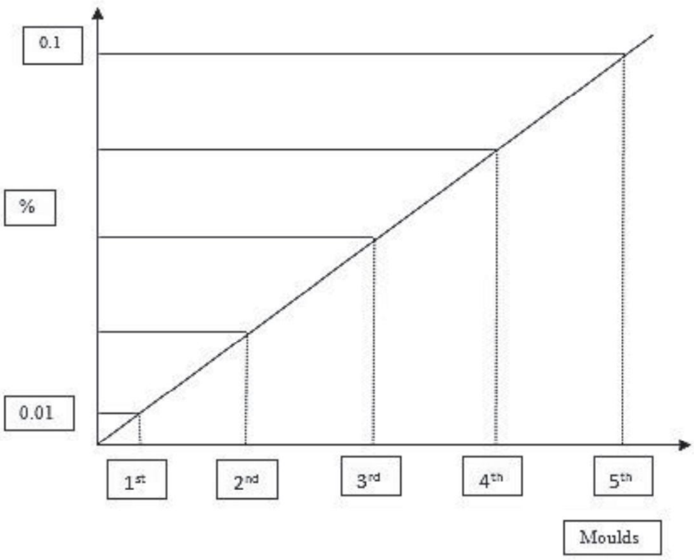

Figure 4: Carbon Content in FeSiCr Cast Metal in the Moulds

The first mould has low carbon content and the last cast records a higher level of carbon because it is at the point of metal/slag interface. Ferrosilicon chrome ingots are selected according to the carbon from each mould. The use into the LCFeCr is according to carbon grades in order to produce LCFeCr product of desired carbon quality.

The moulds for casting must be prepared with FeSiCr fines or granulated LCFeCr slag whose carbon content is less than 0,035% to reduce the carbon contamination in the metal.

In the relationship of silicon content and carbon, the higher the silicon the lower the carbon and also a better reactivity of the process.

Moulds can be made of cast iron which therefore eliminates the need for preparing with metal fines or slag to reduce contamination. Casting is done directly in these chill moulds.

4.2 FeSiCr Preparation for LCFeCr Process

FeSiCr after carbon selection is crushed to the following sizes 10 x 30 mm of 3 x 10 mm with final carbon analysis determined before being utilized in the process. During crushing a draught of air is passed on the discharge end of the conveyor at right angles to the belt discharge to blow any contaminates (external carbon source) to keep the carbon quality. The crushed material is stockpiled in preparation for use into the LCFeCr process but the material is always covered to avoid foreign contamination.

A grading according to silicon content is done to effectively guarantee a good reaction which if hot enough also burns away some carbon from the "coolant" ore (from organic material contaminates). It therefore means the selection after crushing will not favour low Silicon content Ferrosilicon chrome even if the carbon is low due to poor reactivity of this material.

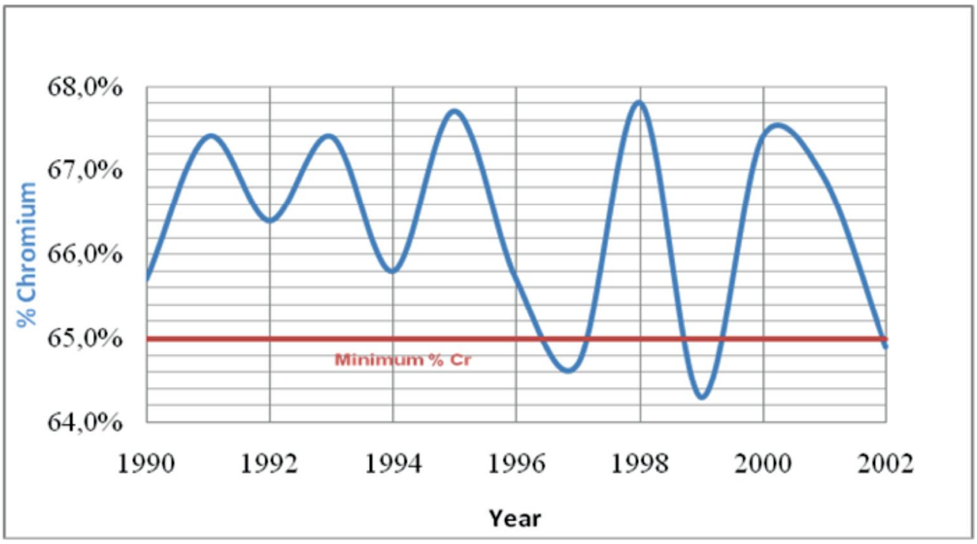

Figure 5: Low Carbon Ferrochrome Metal Chromium Content Conformance

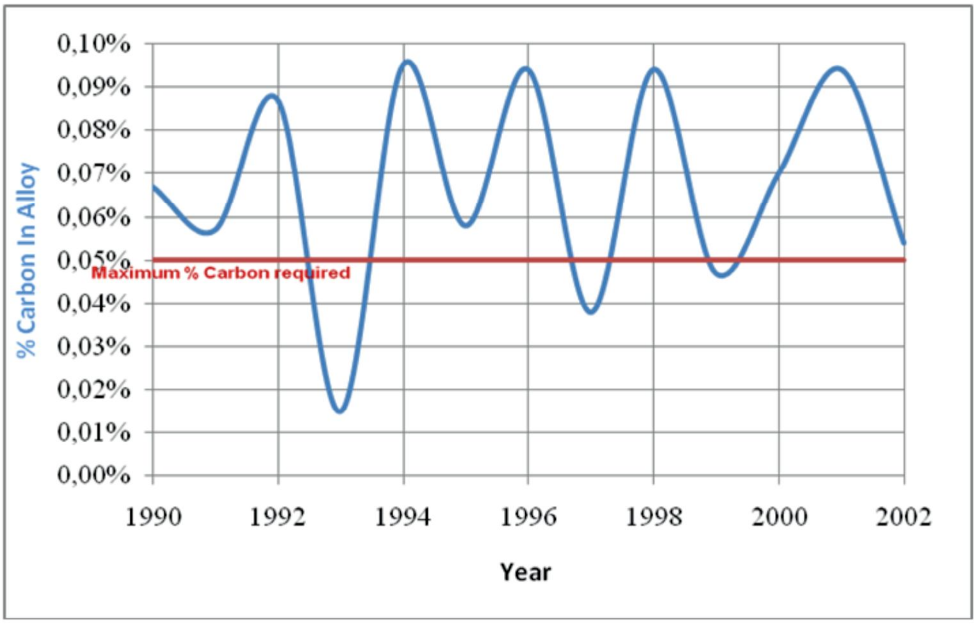

Figure 6: Low Carbon Ferrochrome Metal Carbon Content Conformance

Analysis of product conformance is showing that carbon is mostly out of control as compared to the chromium content. Handling of the Ferrosilicon Chrome after crushing before discharge into LCFeCr process must be strict to avoid contamination as seen on the sensitivity of carbon.

Covering of the material after crushing process is recommended to avoid any contamination of carbon in particular.

5. RESULTS

Results of improved handling and process control of FeSiCr on LCFeCr grades are shown below.

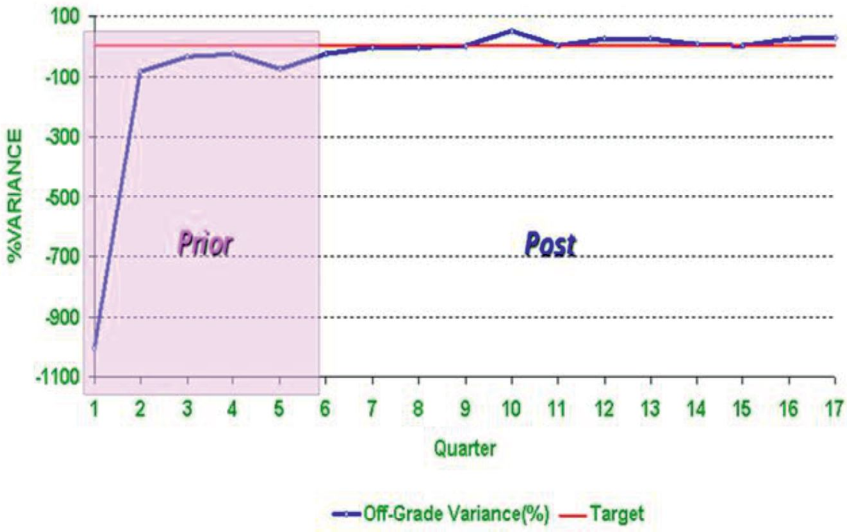

Figure 7: LCFeCr Carbon Quality Prior to Strict FeSiCr Control Compared to Post Control

The diagram shows the quality relationship of product with respect to carbon of LCFeCr prior and post FeSiCr handling and process improvements.

6. CONCLUSION

Carbon and silicon quality are important elements in FeSiCr metal to be used as reductant in LCFeCr production process. The production and handling process of FeSiCr is more important in coming up with LCFeCr product whose carbon quality is among the best in the world of LCFeCr producers.

The conformance of carbon quality in LCFeCr showed a huge improvement with the management of carbon in Ferrosilicon Chrome metal.