RIO TINTO IRON & TITANIUM INC.
Sorelmetal®
Suggestions for Ductile Iron Production

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RECARBURIZATION OF DUCTILE IRON

by
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The quantity of carbon introduced in Ductile Iron melts by the charge materials (i.e. **Sorelmetal**, steel scrap and Ductile Iron returns) is usually lower than the value targeted in the finished castings (usually 3.0 to 4.0% C). Typically, carbon units need to be added to the melt. As with all charge materials, the quality of the resulting liquid melt is a function of the quality level of the recarburizer.

Using a high percentage of **Sorelmetal** in the charge, which contains 3.5 to 4.5% C depending on the grade, is the easiest route to bring carbon into the melt. As shown in Figure 1, **Sorelmetal** has a consistent, reproducible carbon content; moreover its carbidic structure ensures rapid dissolution of carbon into the liquid bath and the typical carbon recovery is 95% or greater.

In practice, most foundries utilize some steel scrap in the metallic charge. The percent steel scrap is a function of price, availability, alloy level and other economic factors. As a result, this necessitates the use of some charge carbon. This is a critical process step that requires attention and close control by the foundryman.

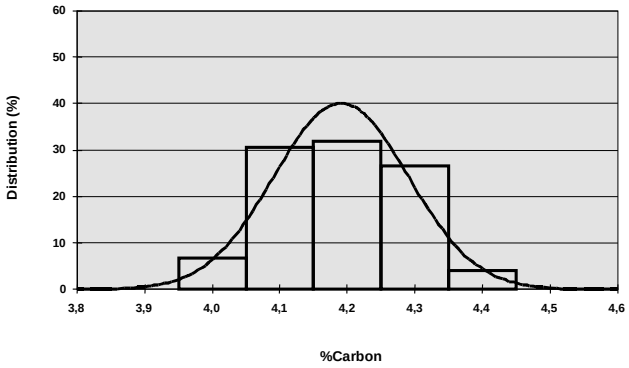

Figure 1. Carbon Distribution in Sorelmetal (F Grades).

A list of various types of recarburizing materials used by the Ductile Iron foundries is presented in Table 1. All elements/compounds, other than carbon, eg. sulphur, nitrogen, hydrogen, ash, moisture, volatiles, found in these materials are harmful for Ductile Iron castings production. This is particularly the case for low cost, low quality recarburizers, such as metallurgical coke or amorphous graphite. Foundries have recognized that many defects, which are listed in Table 2, may originate from such recarburizers and the use of high quality recarburizers is becoming a common practice in the industry. The higher price and variable recovery of carbon from recarburizers often justify an increased amount of **Sorelmetal** in the charge. As illustrated in Figures 2 and 3, using a high proportion of steel scrap requiring large quantities of recarburizer implies i) additional amount of energy to melt the steel and to dissolve the recarburizer and ii) longer melting time that reduces the productivity of the foundry and affects the metallurgical quality of the iron.

TABLE 1

COMPARISON OF TYPICAL RECARBURIZERS

Type	Carbon %	Ash %	Volatiles %	Moisture %	Slphur %	Nitrogen ppm	Hydrogen Ppm	Oxygen ppm
Synthetic produced recarburizer	99.9	<0.10	<0.10	0	0.015	30	25	50
Acetylene coke	99.6	0.15	0.30	0	0.030	440	2175	150
Petroleum coke	99.2	0.10	0.25	0.25	0.090	200	600	275
Electrode graphite	97.5	0.40	0.15	0.15	0.050	50	200	1400
Graphite pellets	97.5	0.30	2.20	0.15	0.020	360	1065	9430
Metallurgical coke	87.2	10.80	0.80	0	1.150	9090	2980	70600
Amorphous graphite	69.4	26.80	3.10	0.10	0.570	750	220	141400

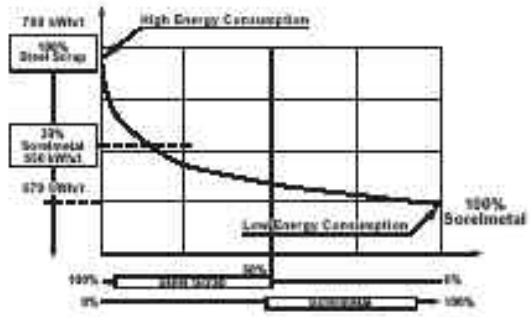

Figure 2. Melting Energy Consumption in Relation to the Charge Composition.

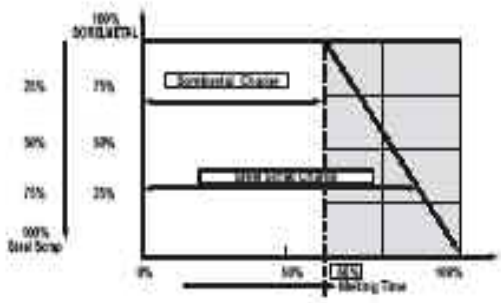

Figure 3. Melting Time in Relation to the Charge Composition.

TABLE 2

RISKS WHEN USING RECARBURIZERS

-	Gas defects
-	Slag defects
-	Inclusions
-	Surface defects
-	Gas and slag defects under the surface
-	Machining problems

The recovery of carbon from the recarburizers is influenced by a number of parameters. They include: the composition and particle size of the recarburizer, the liquid iron temperature, the time and degree of stirring, the carbon equivalent of the iron, and the cleanliness of the melt. Additionally, recarburizers have a typical density of 2.1 to 2.3 g/cm^3 versus 7.3 g/cm^3 for iron. As a result, the recarburizers tend to float on the iron and are easily trapped in any slag layer on top of the melt.

Medium frequency coreless melting has become increasingly popular in Ductile Iron melt shops. These medium frequency furnaces are often used as batch melters. Operators report the following suggestions for optimum melt rate and carbon recovery with this melting equipment.

i) Place **Sorelmetal** ingots at the bottom of the furnace to protect the bottom refractory during charging. Since **Sorelmetal** melts at a low temperature relative to steel scrap, this practice rapidly produces a liquid iron heel.

ii) Charge returns, steel scrap, recarburizers and other alloys on top of **Sorelmetal** ingots. The recarburizing material should be distributed in the ferrous materials to increase the dissolution rate of the material. It is typically charged between the first or third quarter of the steel portion of the charge.

Top the charge with the remaining fraction of **Sorelmetal**. As **Sorelmetal** melts at low temperature, it will flow over the scrap/recarburizer mix and improve carbon dissolution.

If final carbon trimming is required, add it to clean iron surfaces. Recarburizers tend to remain entrapped in the slag, reducing the carbon recovery.

For more information, you can always contact any of the **Sorelmetal** Technical Services.