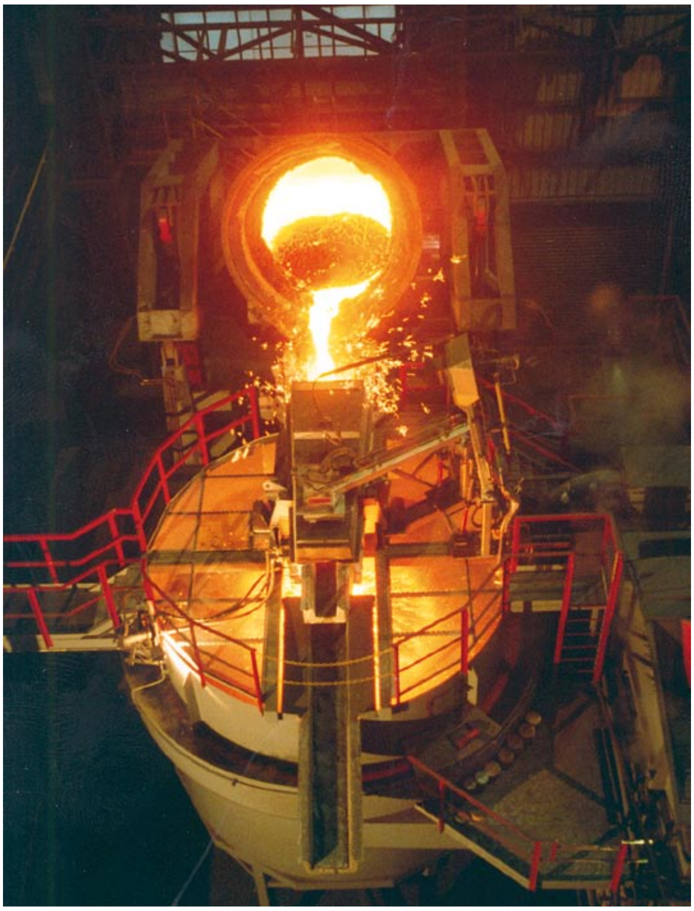
Iron Granulation in Integrated

Installation of a granulation route for iron handling down stream from the iron-making unit in an integrated steel plant has proven to be a feasible solution in order to boost total plant steel output. Disturbances due to iron-making production interference are eliminated and the iron-making unit is allowed to operate at peak performance at all times.

Besides the increased pig iron output, the more stable iron-making conditions results in other operational benefits. The pig iron composition and temperature variations are reduced which decreases the steelmaking operational costs.



The Granshot plant at Voest-Alpine, Donawitz.

By PER-ÅKE LUNDSTRÖM

Iron granulation is a cost-effective method of handling excess iron, fulfilling all basic requirements such as high capacity, low cost operation and prime product material. The granulated metallic material shows excellent chemical and physical properties and is used as a prime raw material in the steelmaking operations.

Voest-Alpine Stahl in Donawitz, Austria and Mittal Saldanha Steel, Saldanha Bay, South Africa have installed Granshot plants for granulation of iron during periods of disturbances and maintenance of downstream equipment. Both plants are designed for granulation rate of 120 ton per hour.

A third Granshot plant will be in operation at SSAB Oxelösund in Sweden in June 2007 with a capacity of 240 tonnes per hour in a single unit. The plant is designed to granulate 100 % of the Blast Furnaces' production.

The installations replace the traditional sand pit casting (pooling, plating, beaching) of excess iron, which causes severe environmental dust problems.

Liquid iron logistics

Integrated steel plants operate with little buffer capacity. Normally the buffering between the blast furnaces (BF) and the steel plant is a fleet of torpedoes, which may have a buffering volume corresponding to 5–10 hours of the BF production.

At any unexpected disturbance in the steel plant or at planned maintenance, which lasts for a period exceeding the buffering capacity the excess iron has to be taken care of. The most common way of handling this is to send the torpedoes to a sand pit casting area and to reduce the BF production rate.

Longer steel plant down periods always causes the BF to turn down completely. The reason for turning down the BF is due to that the casting method creates undesirable side effects. Sand pit casting results in severe dusting, solidification is slow and the solidified product, which normally contains a lot of sand, has to be broken up in pieces at a considerable cost.

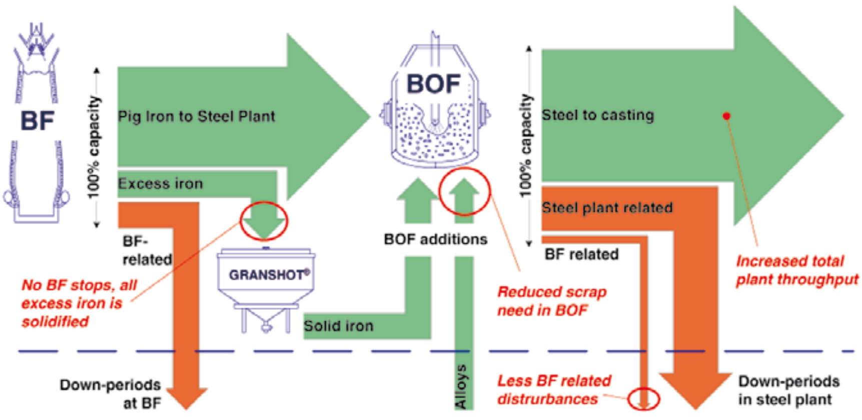
Iron granulation is a more environmental friendly method, which has several advantages as a parallel route for the iron as soon as the liquid buffer is full. In fact it is desirable to continue to run the BF at normal production rate and produce iron granules. The product properties are excellent for automatic handling and usage as prime iron units in house or for external sales.

Granulation of liquid iron

As a back up facility, replacing sand pit casting in an integrated steel plant, the granulating system has to meet a number of fundamental requirements:

- Short start up time to meet last minute decisions
- Easy to operate (operators will also be assigned to other tasks)
- High production capacity matching the BF output
- Prime iron product without any additional processing
- Low environmental impact
- Flexible layout in order to meet existing space available
- Low operational and maintenance costs
- Feasible investment cost

Without sacrificing a good product quality the granulation rate has to bee high to match the BF production rate. For a granulation rate of 240 tons/h the generated power that is transferred from metal to water is about 80 MW. With this



Schematic view of metal flow in integrated steelmaking with granulation as a back-up system.

magnitude of power in a water system the power has to be distributed to the water in a way securing that the power concentration (Power/volume unit) is less than critical concentration for vapour explosions.

In the Granshot system for high granulation rates the liquid metal is split up against an impact refractory disc placed in the centre of a cylindrical water tank. The disc oscillates vertically up and down in a controlled manner, distributing the metal over a large surface area. The method reduces the power concentration in the water basin and hence allows a high metal flow rate.

Iron granulation plants

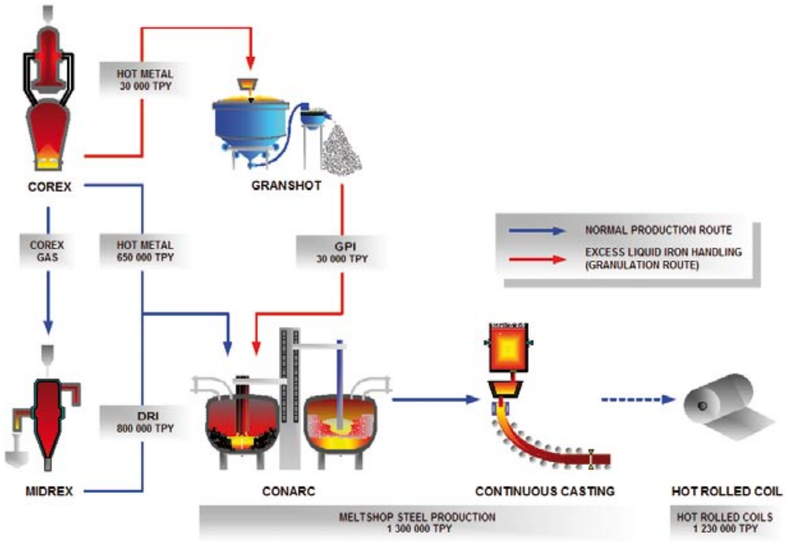
Voest-Alpine, Donawitz, Austria installed a Granshot plant in 2002. The unit is located inside the steel plant premises. The major task is for pig iron granulation, but its location also opens for steel granulation. The material produced is used as an additive in the converters or is sold as feedstock to other steel plants.

At Mittal, Saldanha Steel in South Africa the plant is located in a stand alone building. Excess iron produced in the Corex iron-making unit is transferred to the granulation facility in ladles. The produced granulated iron is used as raw material in the down stream Conarc electric steelmaking furnace, partly substituting merchant scrap and internally produced DRI.

SSAB Oxelösund will have a Granshot plant up running in June 2007. It is designed for a granulation rate of 240 tons per hour continuously over a period of 14 days while the steel plant is shut for maintenance during summer vacations. The plant will be located in the meltshop. Desulphurised liquid iron is tapped from torpedoes to 200 tons transfer ladles equipped with bottom slide gate nozzles. The transfer ladles are placed in a turret and the metal is granulated via a tundish in a similar manner as in continuous casters.

Use of granulated iron

By running the BF at peak performance at all times with a back up of a granulation system a prime iron product is generated, which has excellent properties for internal use or for sales to external consumers.



Granulation integrated in the material flow at Mittal Saldanha works in South Africa.

Addition of granulated iron in the BF

Adding metallic iron on top of the BF, in a cupola-similar manner, increases the production of liquid pig iron. The granulated pig iron has a suitable size and shape suited for the purpose. It should be stated, however, that this method is only used in integrated plants where the BFs are run at maximum capacity and an increased hot metal output is desired. Typically, this is the case where the BFs iron output is insufficient to fully utilize the steelmaking plant capacity.

Addition of granulated iron in the BOF

In general a high-carbon material must be added during the early stages of the BOF operation in order to avoid late carbon dissolution into the melt. Failing to do so, dissolution of carbon will cause a heavy boil and increase in carbon level. These considerations are of special importance if larger pieces of iron are used as additive.

When using a smaller size iron, a relatively late addition can be accepted due to a more controllable dissolution time. A smaller sized material can also be added using an overhead bin system with continuous feeding, allowing an exact amount to be added at the most suitable time controlling composition and temperature in the BOF.

Trials with additions of small-sized solid iron into a BOF confirm that the material in practice behaves like any good scrap grade, i.e. a swift melting and dissolution into the liquid steel. The added iron is a chemically neutral addition in the BOF, merely increasing the liquid metal mass and decreasing temperature on addition.

Addition of granulated iron in other operations

Solid pig iron is a prime raw material substituting scrap and/or other iron sources. Thus, it fits the requirements in melting operations such as induction or electric arc furnaces. In the case of using solid iron in the electric arc furnace operation the large portion of latent energy in solid iron, primarily dissolved carbon and silicon, can be used for heating/melting if oxygen lancing is utilized.

Compared to other iron sources, solid iron is not containing any unreduced material or gangue, and the residual level is low. The material may also be continuously fed into the furnace, which increases productivity due to reduced heat losses and less number of charging baskets.

Solid iron may also be used as a carbon-bearing additive in ladle operations. The carbon dissolved inside the iron matrix is then governing for a precise and reproducible addition. Naturally, the above mentioned method is only possible given that other elements allow the steel to stay within specification. ■