# CHAPTER - I

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The quality of pig iron produced in the blast furnace is deteriorating i.e. silicon, sulfur and phosphorus content of pig iron is increasing due to the deteriorating raw materials quality, particularly that of ore and coke used in blast furnace Use of this low quality pig iron creates a tremendous operational difficulties in the subsequent steel making processes. The increase volume of slag leads to unstable BOP operation i.e. extensive foaming, slopping and splashing resulting low production rate and high production cost. As a result refractory consumption also goes high.

This has lead to a world wide interest in pretreatment of hot metal to reduce the silicon, sulfur and phosphorus content of the hot metal. The pretreatment helps the steelmakers to

i) decrease the CaO consumption

ii) stabilise the BOP operation

iii) produce steel with ultra low in P and S, and

iv) decrease steelmaking cost.

In the blast furnace operation, this in turn helps to use fuels (coke, oil or natural gas) with high sulfur content and to achieve lower silicon content in the hot metal which permits the coke rate to be reduced and the performance to be increased. (l)

In 1950's desiliconisation and dephosphorisation of hot metal by use of lime based fluxes were eagerly studied to increase the production of open hearth furnace. Although such interest has attracted less attention after extensive introduction of BOP, hot metal desiliconisation has revived in some countries as an extensive measure to reduce the output of steelmaking slag. In our country DSP adopted such desiliconisation process which is still under practice.

Hot metal dephosphorisation on the otherhand were not of potential use despite worthy works since evolution of CO bubbles during oxidation of the additives of oxidising basic fluxes caused significant slag foaming, inhibiting further process of dephosphorisation.

However increasing demands for steels of extra low in P and urgent requirement to decrease the iron loss in BOP for better yield have again provided good reasons to reconsider the hot metal dephosphorisation to optimise steelmaking process. The load of phosphorous in BOF has been raised recently as a result of high tapping temperature, being necessary for the Ladle Metallurgy and the continuous casting. Thus phosphorous load in BOF has to be reduced. Out of all the pretreatment processes, the external desulphurisation of hot metal are most popular and studied quite extensively. A variety of desulfurisation processes have already been developed and put into practice. In India recently RSP has adopted such a process based on $CaC_2$-based desulfurising agent.

Recently studies have been made in Japan to demonstrate the possibility of ''slag free'' refining of hot metal. It is well known that a substantial reduction in P, Si and S can be obtained under oxidising condition for instance by way of treating the hot metal with soda ash or with similar active alkaline salts. The slag reaction in the converter are then no longer required or to a limited extent. Such a refining operation which is meant for decarburisation alone could become increasingly important for steelmaking.

Soda ash has been used so far for simultaneous DP and DS for low-Si content P.I. This process is mostly developed and practiced in Japan, where in general Si-content of P.I. is low (0.3-0.4 % ). Even with such low Si-content, Japanese Metallurgist prefer to further reduce silicon to 0.1-0.15 % before simultaneous DP and DS by soda ash. Desiliconization (DSi) reaction is carried out by different reagents such as iron sand and mill scale mixed up with various amounts of CaO, $CaF_2$ and $CaCl_2$ etc. Depending upon the capacity, about 30-60 Kg/ton of reagent was used. Even with such low Si-pig iron, slag foaming is reported to be a problem. Vacuum slag cleaner is invariably used in such cases.

In India, the situation is different and more critical. The silicon content is as high as 1.80 to 2.00 percent. Such a high silicon content compels to adopt a double slag practice. The sulfur content is going up day by day. At Rourkela Steel Plant the sulphur content goes upto 0.08 to 0.10 percent. Lining life of the L.D. vessel is much lower in comparison with other countries. The operation of L.D. process is also erratic and unstable. Removal of such high silicon, before simultaneous DS and DP as it is done in Japan, will need a large amount of flux, consequently large volume of slag will be generated. Handling of such huge volume of slag will not only be a difficult job but foaming of slag will impose a formidable problem. On the other hand, Indian pig iron is physically cold (1280-1290$^{\circ}$C). Therefore adoption of two stages oxidizing process may not be practically feasible.

It is therefore thought that if the Si, S and P content of pig iron could be reduced to certain extent before it is used in the subsequent steelmaking process, all the difficulties mentioned above can be overcome and the quality steel could be produced, cutting down the production cost. Keeping this view in mind the present investigations have been conducted on hot metal refining process having provisions for simultaneous desiliconisation, dephosphorisation and desulfurisation.

Indian pig iron contain 0.3 % P, and 0.05-0.08 % S and is therefore, considered unsuitable for S.G. ironmaking. Most of the S.G. iron produced in India is made from mild steel in Induction furnace and adjusting the composition by adding costly Fe-Si, petroleum coke etc. This is a costly and power intensive process ; therefore, economical for the large foundries. Another aim of this work was to produce cast iron suitable for making S.G. iron from raw materials available in India. The Indian standard specification for making S.G. iron demands $P < 0.08$ % and $S < 0.02$ %.

In general, graphite crucible was used to melt the pig iron. Both addition and injection technique were used to remove the impurities by adding/injecting soda ash-based flux. The change in concentration of phosphorus, sulphur and silicon of the hot metal were determined by sampling the metal phase at regular intervals.

The results would suggest the extent of removal of different impurities under different experimental conditions and thereby the overall reduction in metallurgical load of the subsequent steelmaking process. It is hoped that the results of this basic study on pretreatment of hot metal by soda ash-based flux will contribute to unit process development to new steelmaking routes.