

Some experience in the production of high silicon Fe-Mn at Tisco Joda Plant

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ABSTRACT

The paper describes the experience gained over the last few years in the production of Silico manganese at Ferro Manganese Plant, Joda.

The quality of the quartzite is a very important factor governing the level of silicon in the alloys. An alloy of 16% silicon could be produced successfully with 96% SiO₂ in the quartzite.

Trials in the production of the alloy and the improvement effected of its grade has also been discussed.

Introduction

Tata Steel has set up two 9000 KVA capacity submerged arc smelting facilities at Joda, for the production of high-carbon ferro-manganese. The same, went on stream in 1958. After the operations were stabilised, the Plant was able to operate at a rate, exceeding its rated capacity of 30,500 t per year, of high-carbon ferro-manganese. In 1968, plans for diversification of production were drawn, and under the guidance of the Research & Development Division, Jamshedpur, trial production of silico-manganese by the simultaneous reduction of Mn ore and quartzite was taken up. The results proved the same to be quite feasible, and an alloy with 10 to 14% Si could be produced, with quartzite analysing 90 to 93% silicon.

A 5t steel making furnace was also planned

to be installed, to refine the Si-Mn to produce medium-carbon ferro-manganese. The facility went into operation in 1972.

During the period, 1970 to 1978, limited quantities of Si Mn, required mainly for use in the production of medium-carbon Fe Mn was only made. Thereafter, however, there was an increase in demand from the works, and production of the same was planned for 4 to 5 months in a year in one furnace.

From 1980 onwards, one furnace was earmarked for production of this alloy, throughout the year. The plant produced, a record, 10,564t of Si Mn in 1982-83.

Table-1 shows the annual production of silico-manganese, during the last five years (1978 to 1983).

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TABLE—1
*Annual production of silico manganese
during period, 1978 to 1983*

Year	Production, t.
1978-79	2694
1979-80	3944
1980-81	8392
1981-82	7230
1982-83	10564

Raw material :

Chemistry of Quartzite

During the initial period, quartzite from the Company's quarries at Kendadih, with an average analyses of 90 to 92% silica was used. However, due to wide fluctuations in the analyses of quartzite from 86 to 93%, the grade of alloy produced was not satisfactory, analysing 8 to 14% Si. Alternate sources for supply was arranged and a specification of 94% silica (Min) was laid. With the change in quality of raw material, although there was an improvement in average analyses, the fluctuations in analyses were wide and in the range 10 to 16% Si.

In 1981, the Tisco indicated, that they would like to have Si Mn. with a min. of 16% Si. If the Joda Plant could supply this grade of alloy, it would be very helpful to them. In order to meet this requirement, the specification for quartzite was changed to 96% SiO₂ (Min). This enabled an alloy with 15 to 19% Si to be produced.

Decrepitation of Quartzite

Some of the supplies of quartzite, contained pieces, decrepitated in the furnace, resulting in drop in the grade of silicon. A visual examination of the supplies showed, that there

were pieces resembling quartz which analysed over 96% SiO₂ and were highly susceptible to decrepitation. The suppliers were advised to segregate these pieces at the mining stage itself, to avoid this problem.

Size Range of Quartzite

In the beginning, quartzite in the size range of 10 to 62.5 mm was used. It was found, that the larger pieces, emerged from the furnace, unreacted, resulting in not only drop in the grade of alloy but also in wastage of material. The size range was therefore lowered in stages, to 10 to 40 mm. However, suppliers expressed their difficulty in offering material to this close size range. The tolerance limit for oversize was relaxed to 15% and gradually lowered to 10% and finally to 5%. With quartzite sized to 10 to 40 mm with under 5% oversize and analysing +96% silica, it has been possible to achieve 80% of the alloy, with an analyses of over 16% Si.

Operating practice :

Two types of slag practice, are employed in the production of silico manganese. The "low-basicity" practice attempts a slag with a basicity in the range, 0.22 to 0.32. With this practice, the slag volume is lower and the slag is more fluid, specific power consumption is lower, and productivity is higher. However, the Si content of the alloy produced is lower, due to lower degree of reduction of quartzite.

The "high-basicity" practice, with a slag basicity in the range, 0.35 to 0.42, results in improved degree of reduction of quartzite and hence an alloy with higher silicon. However, the slag is more viscous, the specific power consumption is higher, the slag volume is larger and productivity is lower.

In the plant, both these practices have been tried, to obtain an alloy quality required by the works and the demand of the Med. C. Furnace.

Silico-manganese with +60% Mn and +16% Si.

With the availability of quartzite of the requisite quality, it was found possible to obtain over 75 to 80% of the production, to analyse over 16% Si, particularly with the use of the "high-basicity" practice. However, the Mn. content of the alloy was generally below 60%, and in the range, 57.8 to 59.5%.

This shortcoming was also successfully overcome, by the use of about 10% of Mn. ore with a marginally better quality. Blending three different ores, with Mn/Fe ratios varying from 4.8 to 6.0, it was possible to produce about 80% of the production to conform to +60% Si

Summary and Conclusion

The experience gained over the last few years in the production of silico manganese at the Joda Plant, can be summarised as below :—

The quality of the quartzite, is a very important factor, governing the level of silicon in the alloy. Where the quartzite analyses 93-95% silica, alloy with over 16% silicon can consistently be produced, by adopting the high basicity practice.

When quartzite quality is assured to be over 96% silica, even with the use of low basicity practice, an alloy with over 16% Si could be produced.

Plant for the future

The reserves of high grade manganese ore are fast depleting in the Orissa sector. Ferro manganese plants in M.P., Maharashtra area, are operating their Fe Mn plants, with the high Mn. slag practice. Such a slag, analysing 38 to 40% MnO and 18 to 22% silica, is an ideal raw material for blending with medium grade ores of Orissa, in the smelting of silico manganese. Not only there is recovery of valuable Mn, from the slag, but some quantity of quartzite is also saved due to some reduction of the silica from the slag.

The high freight rates for transport of the slag from M. P., Maharashtra, to plants in Orissa, preclude their use at the present moment. Concessional freight rates, can render the use of such slag, economical and beneficial.

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Discussion

G. Rangarajan, Maharashtra Electros melt Ltd., Chandrapur

Q. Can you tell us some thing about the physical nature of quartz to be used? For example can crystalline quartz be used.

A. No

Q. What is the specific power consumption per tonne of Si Mn produced?

A. Specific power consumption is 4200 kWh/tonne for low basicity and 5000 kWh/tonne for high basicity operation.

Q. Can you give us the consumption of (a) ore (b) quartz and (c) coke for producing one tonne of Si Mn?

A. (a) 2050 kg/t (b) 850-900 kg/t (c) 780-820 kg/t.

Q. Any comments on reductants for use in production of Si Mn?

A. No comments

M. Subramanian, FACOR, Shreeramnagar

Q. It was indicated that use of high Mn. slag will be ideal if it is made available by less freight cost. Have such slags been tried at Joda plant in production of high silicon ferro manganese? If so what proportion of Mn. ore was replaced and how is the recovery of Mn as compared to manganese ore usage? What is the power consumption using the slag?

A. We have not conducted any plant trials.