Ferro Alloy Industries in the Liberalised Economy
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Agglomeration of Chrome Ore Fines for Ferrochrome Making – A Step Towards Increased Competitiveness

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ABSTRACT

Although India ranks 3rd in the World with regard to chromite deposits, competitive production of ferrochrome suffers due to lack of organised technology for utilising the fines and high cost of electric power. The paper analyses the advantages of using agglomerates in the manufacture of ferrochrome. The various ways and means for agglomerating chromite fines have been discussed with reference to the Research and Development studies at Tata Steel.

Keywords : Ferro chrome making, Agglomeration.

INTRODUCTION

India ranks third in the world with regard to chromite deposits, having 3% of the total world reserves. The proved reserves of chromite in India are of the order of 27 million tonnes. Out of this, more than 95% are available in the Sukinda area of Orissa (Table 1). The major portion of the chromite produced *i.e.*, about 70%, is used for domestic consumption and the rest is exported. Out of the domestic consumption, about 86% is used in Metallurgical sector and the remaining for refractory and chemical industries. Most of the chromite reserves

Table 1 : Recoverable reserves of chromite in India

	(x 1000 tonnes)			
	Proved	Probable	Possible	Total
Total in India	27,404	31,210	29,737	88,351
In Orissa	27,069	30,662	28,660	86,391

in India are friable in nature and occur in the form of fines. About 68% of chromite production is in the form of fines. Direct use of the fines for Fe–Cr production requires high power consumption and leads to instability in operation. As such it is essential to use these fines in the form which makes the production of Fe–Cr economical, the present paper deals with the details of Fe–Cr production in India and R&D efforts for utilising the chromite fines for profitable Fe–Cr production.

PRODUCTION OF Fe–Cr and CHARGE CHROME

The total production of Fe–Cr including charge chrome during 1990–91 in India was less than 2 lakh tonnes which has increased to about 3.2 lakh tonnes during 1995–96. the major contribution is for the production of high carbon

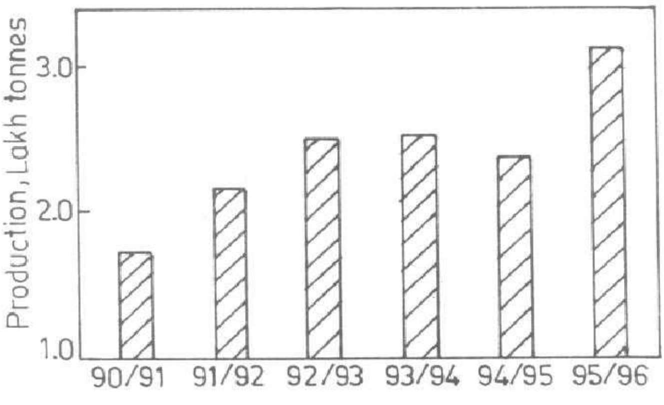

Fig. 1 : Production of H.C. Fe–Cr and charge chrome in India

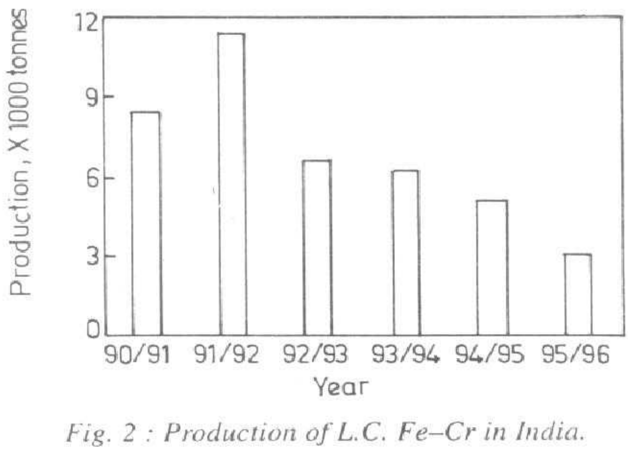

Fig. 2 : Production of L.C. Fe–Cr in India.

ferro–chrome and charge chrome. The proportion of low carbon Fe–Cr was only to the tune of 1 to 5% of the total (Figs. 1 and 2). The total installed capacity is of the order of 400,000 tonnes which includes about 200,000 tonnes of charge chrome. The lower capacity utilisation of the order of 70% is mainly due to the flactuating price of Fe–Cr in the International Market and high cost of power in India. The price of Fe–Cr in the beginning of 1995 was around Rs. 20,000/t, it went up as high as Rs. 32,000/t during middle of 95, again dropped to a level of Rs. 20,000/t during April '96 and again increased to about Rs. 30,000/t during July 1996 (Fig. 3).

Fig. 4 indicates the different constituents of variable cost for production of Fe–Cr. The power consumption is a major element of the order of 35% of total variable cost. The values given in the figure are indicative and may vary from producer to producer. The power consumption for one of the plants using

Table 2 : Power tariff in India

State	Power Tariff, Paise/Unit		
	1994	1995	1996
Andhra Pradesh	240	247	286
Karnataka	227	227	330
Kerala	105	118	NA
Madhya Pradesh	232	247	287
Maharashtra	259	313	361
West Bengal	206	254	NA
Orissa	190	223	288

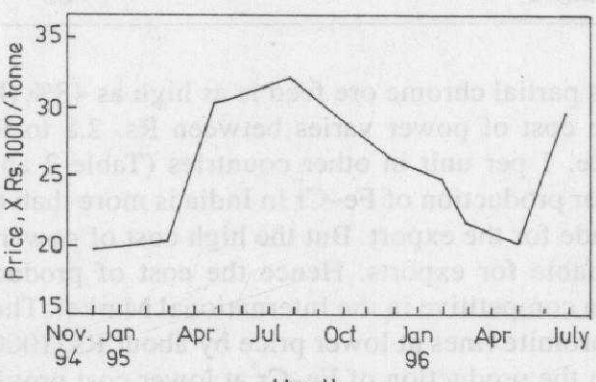

Fig. 3 : Price trend of Fe–Cr.

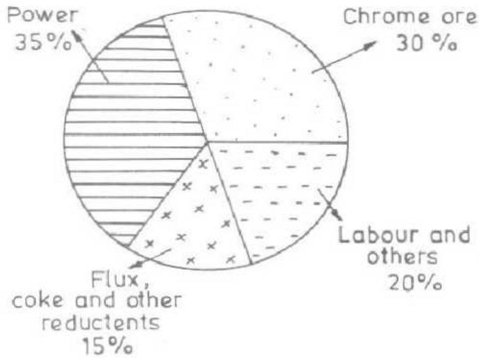

Fig. 4 : Variable cost constituents of Fe–Cr production

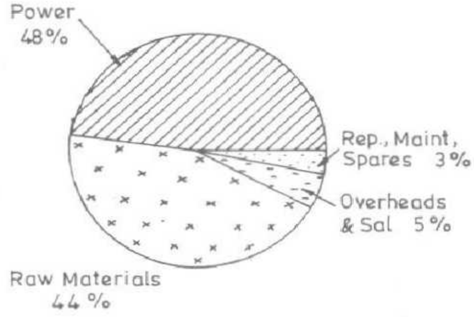

Fig. 5 : Variable cost of constituents of Fe–Cr production (preheated pellets as partial charge)

Table 3 : International power tariff

Country	Tariff, Paise/Unit
Brazil	81
Norway	35
Poland	67
Sweden	102
France	88
South Africa	102
Zimbabwe	63

preheated pellets as partial chrome ore feed is as high as 48% (Fig. 5). In India (except Kerala) the cost of power varies between Rs. 2.8 to Rs. 3.6 per unit against less than Re. 1 per unit in other countries (Table 2 and 3). Since the installed capacity for production of Fe–Cr in India is more than the demand, the efforts are to be made for the export. But the high cost of power makes the Fe–Cr production unviable for exports. Hence the cost of production has to be controlled to remain competitive in the International Market. The availability of large quantity of chromite fines at lower price by about Rs. 1000/t compared to lumps, can result in the production of Fe–Cr at lower cost provided these fines are agglomerated having sufficient strength to withstand degradation during transportation and smelting.

Table 4 : Power consumption with the use of agglomerated charge

Type of charge	Power consumption KWh/t of Fe–Cr
Fines	4600
Lumps ore	4000–4300
Briquettes	3700–3900
Cold Pellets	3400
Hot Pellets	2800
Hot Reduced Pellets	2000–2300

USE OF AGGLOMERATES

Some of the Fe–Cr manufacturers particularly small producers, like to use chromite fines due to its low cost and easy availability. But this results in various operational problems like low gas permeability, breakage of electrodes, high power consumption *etc.* The power consumption with the use of fines is around 4600 KWh/t Fe against 4000 KWh/t for lump ores. The power consumption is as low as around 2000–2300 KWh/t with the use of prereduced pellets (Table 4). As the advantages derivable with the use of agglomerates in one or other form are quite high, efforts must be made for switching over to agglomerages and eleminate direct charging of fines in the furnaces.

The three available processes for agglomeration are sintering, briquetting and pelletising. High capital investment coupled with introduction of gangue through solid fuel prohibits the use of sintering for chromite ores. Briquetting is most commonly used as the investment is quite low and the process is simple. On the other hand, pelletising although capital intensive, is preferred by large producers due to possibility of utilising high grade concentrates which are available in very fine form. In addition, the physical properties of the pellets are far superior to briquettes; which can withstand degradation during processing for preheating and even for pre reduction.

Table 5 : Composition of gas produced from the arc furnace at Bamnipal Plant

$CO = 86.2\%$, $CO_2 = 3.6\%$, $H_2 = 2.2\%$

$H_2O = 2.2\%$, $N_2 = 5.8\%$

The gas produced from the arc furnace is sufficient for preheating the chrome ore feed to the extent of 800–900°C. The gas can also be used for prereduction as it has over 85% CO. The composition of furnace exit gas for the Fe–Cr plant of Tata Steel at Bamnipal (Orissa) is given in Table 5. The generation of the gas is of the order of 4500 m^3/h and only 400 m^3/h is required for essential heating operations like preheating of ladles *etc*. Major part of the gas (3000 m^3/h) is utilised for sintering of pellets and its preheating in the rotary kiln.

R&D EFFORTS ON AGGLOMERATION

Pelletising

The plant at bamnipal (Orissa) was originally designed for production 50,000 tpa charge chrome. Due to high price of Fe–Cr and availability of high grade chrome ores/concentrates from captive sources of Tata Steel at Sukinda, presently Fe-Cr is being regularly produced. The main units of the plant are grinding mill for chromite fines, drum filter, disc pelletiser, double shaft sintering furnace, preheating kiln and submerged arc furnace.

Due to low strength of pellets produced, the plant is using partly (about 50%) pellets and rest chromite lumps, although the plant is designed to use 100% pellet feed in the furnace. The laboratory tests at R&D have established that with proper preparation of feed and pelletising parameters it is possible to produce high strength (100 kg/pellet minimum) consistently at the plant. The optimum conditions are:

Grinding fineness	=	80–85% below 200 mesh
Moisture content	=	12±1%
Bentonite addition	=	1.5%
Sintering Temperature	=	1400°C

Once the recommendations are implemented in the plant, the power consumption is expected to be lower by about 400 KWh/t. This would reduce the cost of Fe–Cr production by about Rs. 1000/t minimum, in addition there would be other operational advantages.

Briquetting

The studies on briquetting of chromite were conducted for improving the operation of Fe–Cr production at Standard Chrome Ltd., Raigarh (MP). Major part of the feed is in the form of fines. Although the plant has briquetting facilities, these were not used due to very low strength of briquettes produced. Studies at R&D have established that with proper proportioning of molasses and lime as binder it is possible to produce briquettes of the following strength under normal operating pressure of roll briquetting press.

i) Green briquette drop strength (2m) = 4 minimum

ii) Cured briquettes (atmospheric curing for 2 days)

Drop strength = 10 minimum

Crushing Strength = 260 kg/briquette.

Heating of these briquettes upto 700°C has resulted in the drop of the strength but the briquettes were sufficiently strong to withstand degradation during furnace operation. Plant scale trials using briquettes as partial charge has resulted in the saving of power consumption by about 250 KWh/t at Standard Chrome Ltd., the cost of briquetting was Rs. 300/t.

Similar tests were conducted by RRL, Bhubaneswar using 20% briquettes in the Ferro–Chrome Plant, Jajpur Road (Orissa) for production of silico chrome in 9 MVA electric arc furnace. The short duration trials have established the increase in productivity by about 1.6% and decrease in power consumption by 3.8%.

CONCLUSION

Fluctuating price trend in the International Market and high power cost in India, forces the Indian Fe–Cr producers to throttle their production. Utilisation of larger proportion of fines which are available in abundance and at substantially lower price compared to lumps, can reduce the cost of Fe–Cr, provided suitable agglomeration techniques are used. The choice can be either briquetting or pelletising depending on the size of plant, finances available and type of chromite fines available. The use of agglomerated chromite feed can result in power saving to the extent of 400–600 KWh/t depending on the quality of agglomerates produced.

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