L8 : POSSIBLE TECHNICAL UPGRADATION PROGRAMME IN CI FOUNDRIES

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1. Indian Ferrous Foundry with Cupola as a melting unit dates back to the first decade of this century. The evolution of Indian Foundry and the distribution of organized and unorganized foundry units and their installed capacities are given in Fig. 1 and 2. Notice the following points : We may reach 4000 units by the turn of the century. With 15% of the total number of Foundries concentrated in West Bengal, the total share of installed capacity is around 40%.

Cupolas have been erected in the later period in dusters at places like Howrah, Agra, Ahmedabad, Batala and Coimbatore. These were erected not by any standard but by simple copying of then existing units by fabricators, with scant respect to design, leaving the operations to take care of themselves. IS 5032-1969 though specified all the dimensions (Fig.3) of the cold Blast Cupola (CBC) specially to suit the small scale industries not much effort has been done to follow. The result is a higher coke rate of 25-33% is common with Indian high ash coke (35-42%).

2. **Diversification - why necessary**

A study sponsored by Dept. of Scientific Industrial Research (DSIR), Ministry of Science & Technology reveals data based on sample survey conducted among 27 foundries situated all over the country, it indicates that melting technology profile to be as below (Fig.4)

Cupola	-	50%
Induction furnaces-		35%
Electric Arc Furnaces-		15%

The type of casting produced in the ferrous foundries is as below :

Cast iron	20
Spheroidal Graphite Iron	4
Compacted Graphite Iron	1
Malleable Iron	1
Steel	1
Total	**27**

This indicates that this industry will rely very much on cupola for many years to come. But as profitability is on the low ebb, diversification based on upgradation of Technology becomes a necessity in the existing SSIs of today. Any diversification or expansion programme should first touch on the modifications to this base unit - CBC, and should be detailedly by probed into and the operational costs should be made economical.

Where do we stand today. With an excess capacity, the comparative figures of India vis-a-vis abroad are as follows :

	India	*Abroad*
Melting/kwhrs consumption/t	700-900	540-600
Coke rate kg/t	330-250-150	100-80
Coke ash %	35-42	10-8
Rejects %	8-20	1-2
National Level Institutional Linkages	Poor	V.Good
Academic Institutional Linkages	V.Poor	V.Good

Table-1 comparative figures of Indian Foundries vis-a-vis Foundries abroad(West)

The process flow of an Indian foundry based on CBC can be detailed as below in fig.5. Now let us consider the basics of upgradation. Upgradation in the Ferrous Industry can be considered in 3 strategies:

1. Short term strategy - includes utilization of existing resources only and adopting I.E. principles for balancing melting, moulding, sand reclamation and sand preparation treating them as separate basic operation.
   - Metallurgical control
   - Ferro alloy addition control.

   Thus optimizing the unit as it is present today.

2. Medium term strategy = includes
   - modifications in the base melting unit - cupola
   - Introduction of Mechanical Moulding & core making equipment, where necessary to improve productivity
   - Mechanized charging, Sand moulding machines
   - Computer aided charging
   - Sand reclamation
   - Mechanical fettling
   - Energy saving in cooling.

   All these itemsaim simultaneously at the reduction of generation of pollutants at source.

3. Long term strategy - investment in the new processes, on new equipment which incidentally brings the operations under check by complying with pollution control laws with a futuristic approach.

   These include modifications to CBC like coke less cupola (CLC)
   Plasma Aided Cupola (PAC)
   Complete Plasma Systems in Cupola (CPSC)

Now let us look into the various parts in the 3 strategies.

Sand reclamation done in wet methods or dry methods. Those adoptable to suit SSI are wet methods

Wet Ball Mill (attrition type). After fettling and shake out, the sand is crushed, screened, and passed through a wet ball mill, dewated, over size metallics are removed and the clean sand is divided in 3 fractions and mixed suitably for reuse. (Fig.6). As a dry method the Fordath Fluidaire sand reclaimer was studied by the DSIR group and was recommended for resin sand (Fig.7).

Modification to the base melting unit cupola under the short term strategy the CBC can be converted/modified in the following way.

1. Devided blast cupola : The blast that is necessary for the operation is devided into two sets of tuyers at different levels. The second set is generally at a higher level and is intended mainly to increase the heat of combustion of the carbon monoxide formed due to carbon dissolution according to the reactions :

   $Co_2 + C \longrightarrow 2\,CO$ Carbon dissolution

   $2CO + O_2 \longrightarrow 2CO_2$ Secondary Combustion reaction

   This reduces the coke rate up to 25%
   Increases the melting rate by 20%
   increases 50°C in metal temperature
   increases 0.2 carbon pick up.

   Two designs - one of BCIRA and another 9 tuyere cold blast cupola are showing in Fig.8.

2. Equi Blast cum Balanced Blast Cupola

NML has designed for modification of the existing S.S.I. Cold Blast Cupola with the main intention of reducing the coke rate and simultaneously reducing the sulphur and solid particulate matter (SPM) in the outgoing gass in proportion to the reduction in coke addition.

Results 40% reduction in coke rate accompanied by an increase in melting rate; increase in metal temperature; lower labour cost.

54 SSIs have taken our design, 26 in Batala (Punjab) alone. The modifications as per NML design are done under the supervision of NML scientists (Negotiable).

Hot Blast Cupola : The first Hot Blast Cupola (HBC) was set up in Switzerland. This was mostly suitable for high coke consumption 15-17% with 8-10% ash used in the production of Malleable cast iron and with 14-15% coke with the same ash content for grey cast iron.

In the Hot Blast System 80% of the cupola gases are extracted in an undiluted form below the charge opening and 20% only is exhausted through the chimney. The gases pass through refractory lined gas duct into a dust collector and from there into a combustion chamber of a recuperator. The dirty gas is burnt to 100% with the addition of air

$$CO + {}^{1}/_{2}\,O_2 \longrightarrow CO - 3030\ \text{Kcals/kg CO}$$

The gases attain a temperature of 1000°C as passed through a heat exchanger in which cold blast flows counter current and gets heated to 520°C at the recuperator outlet from where it is led to the cupola tuyeres through insulated pipe system to reduce the fall in temperature.

The outgoing dirty gas from the recuperator is passed to stack or through a gas cleaning plant (GCP).

Equipment necessary

a recuperator
a combustion + cooling in blower
a gas fired ignition burner
instrumentation for Hot Blast Control
Protection of heat exchanger shell against over heating

Under Indian Condition with > 35% ash in hard coke used in cupola the shankey diagram for heat distribution for CBC and HBC are as below :

	CBC @ 240 kg/t	HBC @ 160kg/t
Unaccounted	6.6	6.1
Slag heat	1.4	1.0
Coke slag heat	4.7	4.3
Iron melt	23.4	31.3
Sensible heat of top again	13.1	10.1
Latest heat of top gas	40.8	36.3
Radiation losses	10.0	10.0
Total	**100.0**	**100.0**
Efficiencies %	23.4	31.3
Energy Saving due to Blast		8.0
-do- Coke		25.0
Total energy saving in HBC		33.0

By raising the air blast temperature, the sensible heat accelerates the rate of combustion of coke within the cupola and increases the temperature in the melting zone, thereby tap temperature.

The use of oxygen by enriching the air blast: This has been found beneficial in boosting combustion temperature. The value of air blast is kept constant and appropriate amount of oxygen is mixed with air blast to increase the percentage of oxygen in the air from the base 21% up to 24% which has been found to be optimum in a study at NML.

Basic Cupola : For the removal of sulphur in metal through high lime containing slag, a basic refractory (Magnesite) lining is used. The yield resulting in such utilization is low sulphur iron suitable for ductile iron. Incidentally the basic slag increases the carbon pick up even while melting steel scrap. But these refractories are more expensive. Besides loss of silicon in melting is high and operation is very sensitive to control Hence it is not used even in Ductile iron production.

Water cooling of the shell and tuyere: This mainly keep the erosion of refractories in the melting zone under control and cupola campaign can be extended easily to a full week or up to a month, without dropping bottom for refractory patching or repairs.

Cockeless Cupola : The first cokeless cupola is a converted cold blast cupola of M/s Hayes Shell Cast Ltd (UK) in1970 for grey iron. In this function of coke is switched over to gas/oil.

Function of Coke	*Simulated by*
Heating effect of coke	by gas/oil
Super heating by excess coke	by Alumina balls or spheres
carbon in the alloy	by injecting carbon by addition in a duplexing system wherein the electric induction furnace is used for production of ductile iron

As the name indicates when a major portion of coke is removed in the melting the sulphur pick up is reduced and thereby depending on initial sulphur desulphurization by lime/limestone, soda ash or calcium carbide may not be necessary in arriving at low sulphur iron for Ductile/ spheroidal graphite iron.

Note : The process of desulphurisation being endothermic needs heat and hence a higher metal temperature is necessary which can be avoided.

Plasma assisted/complete plasma cupola: Westinghouse and EPRI USA have fitted a 1.5 MW torch at the tuyere and conducted trials in a cold blast cupola. Results indicate cokerate reduced from 132.5 kg to 46 kg/tha. The resulted low flow rate allowed borings and light shreded scrap to be charged with reduced emissions. Cost savings recovered the capital costs in 2 years. On a 2.5 MT/hr. 30" dia cold blast cupola. The sound levels are also reduced.

Since '89 45 T/hr plasma aided cupolas are functioning and design of 60 T/hr capacity have been drawn.

Conclusion

Tile now we are only looking into melt the metal, pour the melt in the mould and see that the surface of the casting is good where as in the present situation when all the user industries are seeking better materials for a desired equipment/usage the SSI foundries are to probe inside their procedures to achieve what is wanted. The foundries need mechanisation in charging and moulding; modifications in arriving at the metal melt needed and co-ordinate their work under supervision of Technical associates from National Laboratories for any possible Diversification from the present situation prevailing in their foundries.

Company	:	Bhavesh And Company 5 Pankaj Estate, Near Gujarat Bottling Co., Rathial, Ahmedabad -- 380023.
Estd.	:	1969- SSI
Product	:	C.I. Casting - Cylinder liners for two & four wheelers 75,000 liners/annum
Premises	:	150 sq.m. built up are on 200 sq.m. land
Eqpt.	:	Four Pit furnaces/30 HP connection
Manpower	:	9 workers + Owner (75,000 lines/annum)

Past Performance

Year	Casting MT	Gross Value (Rs.in lakhs)	Profit (Rs.in lakhs)
1987-88	21	4.2	0.32
1988-89	36	7.1	0.46
1989-90	75	14.8	0.75

Method	:	Conventional sand cast
Problems	:	Low uneven tempeature of metal. High energy consumption due to inferior coke/coal: Rejection due to inclusions in castings)
Suggested	:	Convert coal fired pit fees to oil find farnaces - results in higher melt control reduces rejection
Additional Budget proposed	:	A recuperator for energy savings - 0.64 lakhs in 1990 Dec. 2.00 lakhs at current cost (1994)

DSIR

Company	:	Poonam Casting 3 Bhup Nagar, P-Patel Street, Rajkot - 360 002
Estd.	:	1982
Product	:	Graded CI castings for submersible pumps Centrifugal pumps, M/c tools. 1500 MT/a
Premises	:	Rental
Eqpt.	:	2 cupolas, 1 rotory furnace 2 sand mixers, 2 moulding M/c s
Manpower	:	3 skilled + 3 semi-skilled + 5 unskilled + Partners
Past Performance	:	Good upto grade 25

Year	Casting	Gross Value (Rs.in lakhs)	Project (Rs.in lakhs)
1988-89	400 MT	27.52	1.44
1989-90	210 "	17.85	0.41

Method	:	Conventional sand preparation and moulding
Problems	:	Higher rejection with grades beyond 25 less margin for gade upto 25
Suggested	:	M.F. Induction melting furnace 250 kw/1000 Hz 300 kg crucible Inductotherm Pneumatic moulding M/c & Lab. - Employment of a Foundry engineer - Value added castings, alloy iron & steel

Additional Budget proposed :

Ind. Fce - with accessories & a 400 kva transformer	Rs.22.00 lakhs
Pneumatic moulding M/c and Shot blaster	Rs. 5.00 "
Revised lay-out & installation	Rs 3.00 "
	Rs 30.00 lakhs