Replacement of single blast to energy efficient divided blast cupola

(***For Howrah mixed Cluster***)

Cluster Brief:

Howrah is hemmed in between river Hooghly on the east and river Rupnarayan on the west intersected by the Damodar. The district of Howrah came into limelight with the opening of railways in 1854, following British mercantile colonialism of India. Howrah is presently known as industrial city, and has over 3,000 industries registered. Agro, jute and cotton, rolling, embroidery, engineering spare parts and foundry industry are prominent in the cluster. Howrah is well connected by road and railways. Two major national highways NH-2 and NH-6 are connected to Howrah.

The emergence of foundry industry in Bengal started in mid-19th century, based on necessity of spares for jute and cotton industries. By the end of First World War, Bengal's foundries took shape into what is known presently as Howrah cluster. After independence, the small and medium sized industries owned by the British were sold to the new entrepreneurial community of Marwaris. These firms continue to remain with the second/third generation of Bengali entrepreneurs. In its peak, the cluster had over 500 foundries as well as rolling mills largely due to availability of cheap pig iron and coke and a large pool of skilled/semi-skilled labour. But over the past decade, many non-Bengali industrialists moved out of state and a large number of Bengali owned small foundries were closed down. Inadequate availability of quality raw material, shortage of power, poor infrastructure and active trade unionism are some of the main reasons for the decline of the cluster. The existing industries are also 3-4 decades old and very little investment towards modernization of plant and machinery is done after initial commissioning.

There are about several foundry and rolling mills located in Howrah cluster. These industries provide direct employment to about 15,000 people. All foundry units use cupola for melting, few foundries in past decade have started using induction furnace for producing ductile iron and steel castings. Foundry and rolling mill units are located around city, mainly at: Liluah, Salkia, Benaras road, Belgachia, Dasnagarn, Balitikuri, Jangalpur and Santragachi. Total annual turnover of foundries and rolling mills is above Rs 1,350 crores, out of which 60% is coming from exports. The cluster is known for exporting sanitary castings to several countries in five continents. Over 90% of casting produced in the cluster is cast iron, under 10% of total production is ductile iron and steel castings.

Existing practice:

During energy audit at Howrah region it was found that maximum units are using Blast cupola for melting. The installed furnace is utilized for melting the material at temperature of 1300^{0}C to 1500^{0}C. Furnace remains in operation for 70 days/yr to 96 days/yr.Cupola is the most common type of melting furnace used for the production of grey iron castings in all foundries in Howrah.

Some of the contributing factors that were identified for this poor energy performance are listed below:

- ✓ Incorect blast rate
- ✓ Lower blast air pressure
- ✓ Incorrect distribution of air between the top and lower tuyeres
- ✓ Turbulent (non-linear) entry of air into the cupola
- ✓ Incorrect sizing of cupola parameters such as tuyere area, well depth, and stack height
- ✓ Poor operation and maintenance practices
- ✓ Poor control of feed materials (shape,size,weight,sequence)

Figure 1: Single Blast Cupola furnace

Table 1: SFC at different cupola furnace

Units Name	**Fuel Type**	**Furnace Capacity (TPH)**	**SFC**
Bagchi iron foundry	Hard coke (Local supplier)	5	0.18
Abhishek iron foundry	Hard coke (Local supplier)	4.5	0.18
Shiv durga iron foundry	Hard coke (Local supplier)	3	0.23
Ramkrishna iron works	Hard coke (Local supplier)	2.5	0.17

Proposed technology:

Divided blast cupola (DBC) or twin blast cupola is proven technology for improving the energy performance at a modest investment. A DBC supplies blast air to the cupola furnace at two levels through a double row of tuyeres.

Figure 2: Divided Blast Cupola Furnace

Justification of technology selection:

Use of Divided Blast Cupola furnace will be beneficiary to foundry units using Single Blast Cupola. Some of the advantages of the Divided Blast Cupola Furnace are:

- ✓ A higher metal tapping temperature and higher carbon pick-up are obtained for a given charge –coke consumption.
- ✓ Charge coke consumption is reduced as high as 30% and the melting rate is increased, while maintaining the same metal tapping temperature.
- ✓ Optimum blower specifications (quality and pressure)
- ✓ Optimum ratio of the air delivered to the top and the bottom tuyeres
- ✓ Minimum pressure drop and turbulence of the combustion air separate wind-belts for top and bottom tuyeres
- ✓ Correct tuyere area, number of tuyeres,and distance between the two rows of tuyeres
- ✓ Higher stack height
- ✓ Mechanical charging system
- ✓ Stringent material specifications

Estimated Energy & monitoring saving:

The furnace capacity at Howrah foundry units vary from 2.5 tph to 5 tph. For calculating the energy and monetary benefits, a represntative case of Cupola furnace of 4.5 tph capacity has been

considered. The benefits envisaged through installation of energy efficient divided blast cupola in place of single blast cupola has been summarized in the table below:

Table 4: Cost benefit analysis for single blast to energy efficient divided blast cupola

Parameters	Uom	Existing system	Proposed system
Casting material	t/batch	10	10
Coke Consumption for 4 hour operation	t/batch	1.85	1.48
Ash in Coke	%	31.3	31.3
Blower power consumption (30 kW motor rating)	kW	25	25
Melt Temperature at spout	^{0}C	1345^{0}C to 1478^{0}C	1410^{0}C to 1500^{0}C
Temperature of Flue gas (below charging door)	^{0}C	350	200
rejected Casting	kg	700	490
Actual cost savings per ton of melt output			
coke saving per ton of molten material	kg	36.90	
Monetary cost savings due to reduce consumption of coke per ton of molten metal (A)	Rs./t	554	
material saving per ton of molten material	kg	21	
Monetary cost savings due to less casting rejection (B)	Rs./t	42	
Total monetary cost saving per ton molten material (A+B)	Rs./t	596	
Total monetary cost saving per annual production	Lakh Rs.	7.15	
Estimated investment	Lakh Rs.	10.00	
Simple Payback	months	16.8	

* extracts of calculation provided

The benefits can be summarized as:

- ✓ 18-22 % reduction in fuel consumption
- ✓ 25-30 % reduction in casting rejection

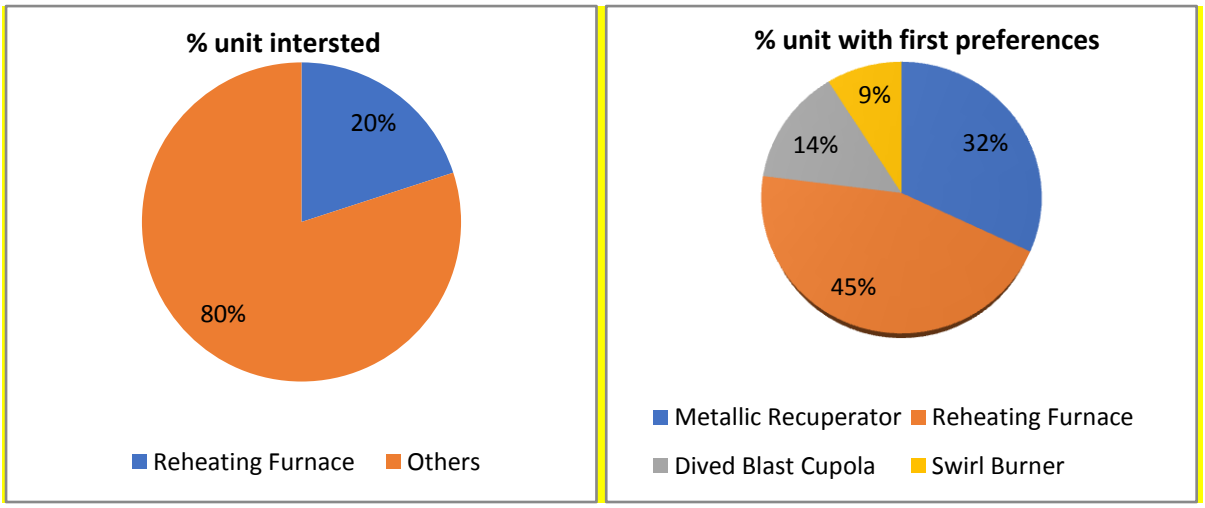
Replication Potential:

Howrah has a large number of iron foundry units forming clusters.The Howrah foundry association (HFA), Howrah chambers of commerce and Industry (HCCI),The Institute of Indian foundrymen are the association operational in the cluster. To establish the replication potential of the technology in the sector, the following were considered:

- ✓ Technology feasibility and adaptability through energy audits in 8 units.
- ✓ Survey of 100 units (under process)
- ✓ Meetings held with associations / stakeholders (including technology suppliers)

The technology of energy efficient divided blast cupola has good demand, with 20 out of 80 surveyed units so far, showing interest for the technology. However, while analyzing the preference of the units on the list of technologies, the technology of boiler automation and control system is third in the list after 'Jet Dyeing PLC' and 'Microturbine for power generation.'

Figure 1: Summary of survey results



As seen from the above, 14% of the units out of 100 surveyed units till date, has opted for 'Energy efficient divided blast cupola' as the first preference for implementation.

Considering the survey results and based on further discussion with associations, units, stakeholders and outcome of the energy audits, it is estimated that the technology has a replication potential of 30% in the cluster, i.e. 30 units. Based on 30% replication, the overall project benefits will be as follows:

Table 5: Impact of replication of technology of Divided blast cupola

Parameter	UoM	Value
Annual thermal energy saving (one unit)	t/y	44
Annual thermal energy saving (one unit)	MJ/y	1,037,994
Annual material saving (one unit)	t/y	25
Annual total energy savings	MJ/y	1,037,994
Annual coal saving (considering 30% replication)	t/y	1,328
Annual energy saving (considering 30% replication)	MJ/y	31,139,821
Annual CO2 emission saving (one unit)	tCO2/y	134
Annual CO2 emission saving (considering 30% replication)	tCO2/y	4,008
Estimated investment in technology (one unit)	Rs in Lakh	10
Estimated investment in technology considering 30% replication (assuming price down due to demand aggregation)	Rs in Lakh	300
Annual CO2 emission saving (in 10 years)	tCO2/y	40,083

Barrier for implementation:

Altough the technology has been successfully proven; there has been limited replication of the technology in the cluster. The barriers identified for limited penetration of the technology in the cluster are as follows:

- ✓ **Knowledge barrier:** Based on discussion with units, it has been found that knowledge dissemination related to the technology has been limited. The furnace automation has been

limited to temperature and pressure control in the units. Most of the units are unaware of other key parameters (including boiler feed fuel and air control) which is important to optimize the furnace performance.

- ✓ **Lack of after-sales service:** The technology penetration has been limited due to the lack of after sales service. The delay in such services forces the units to bypass the automation system. The annual maintenance contract and warranty, which has been inbuilt in the present model, is expected to take care of the issue.
- ✓ **Lack of skiled manpower:** The technology requires skiled manpower and /or training within the existing manpower to operate the system at optimum level. Such training has been incorporated in the model.
- ✓ **Risk related to implementation:** The units lacks confidence related to performance of the technology. The risk of performance has been covered under the project.

Availability of technology supplier:

Energy efficient Divided blast cupola has been well established. A large number of reputed technology supplier cum integrator are involved in supply and service of the technology. Most of these technology suppliers have local offices / representative at Howrah. In addition to the established names, a large number of smaller system integrators are also involved in the supply of this technology. Some of the established technology suppliers who have presence in the cluster are:

- ✓ P S Trading Co. Pvt. Ltd., Kolkata
- ✓ Ma Tara Fabricator, Kolkata
- ✓ Jagdip Industries , Ahmedabad
- ✓ G.R. Plants & Equipments Company, Ludhiyana
- ✓ Industrial Enterprisers, Konnagar, Kolkata
- ✓ Vitthal Enterprise, Ahmedabad
- ✓ M.S. Furnace company,Jalandhar