INSTALLATION OF AUTOMATION AND CONTROL SYSTEM IN STEEL RE-HEATING FURNACE

(***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:

A re-heating furnace is considered the heart of a rolling mill. Typically, top fired pusher type re-heating furnace are used in steel re-rolling mill units to heat the raw material i.e. ingots, billets or scraps to the recrystallization temperature i.e. around 1200 ^{0}C.

Steel re-rolling mill units at Howrah are equipped with furnaces in the range of 3 TPH to 20 TPH which are typically fired using pulverised coal. Out of 4 units there are VFDs installed in 1 units at the FD / ID Fans of furnace, the air flow control is manually done in most of the units. Studies suggest that most of the units fail to maintain the correct amount of air in the combustion chamber, required for optimum combustion. This leads to incomplete combustion with a significant percentage of the heat loss through dry flue gas . The excess air flow can be determined by the free oxygen percentage in the flue gas which automatically leads to higher excess air percentage. Also, the draft pressure is not monitored and controlled to the desire level. The following table shows the variation in the oxygen percentage in different units with coal as fuel:

Table 1: Excess air level at different re-heating furnaces

Units Name	**Fuel Type**	**GCV**	**Furnace Capacity (TPH)**	**Oxygen Percentage (%)**	**Excess Air (%)**
Hooghly alloy and steels	Coal (Imported)	5,600	20	7.7	57.5%
Arjan dass & sons	Coal (Imported)	5,600	5	9.4	81%
Crowm metal industries	Coal (Assam)	6,495	2.5	10.3	97.4%
BSW rolling mills	Coal (Imported)	5,332	3	10.3	97.4%

Proposed technology:

Optimum furnace efficiency can be achieved through complete automation and control system in the furnace. To start with; all furnaces should be equipped with basic monitoring instruments like thermocouples. Automation & Control system for re-heating furnace exists in three levels:

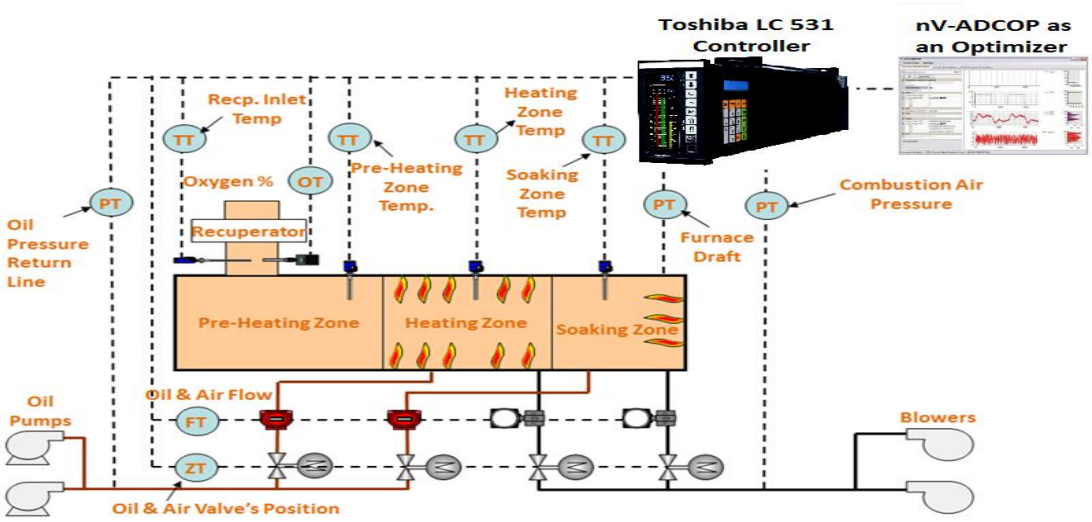
Level 1: On-off Control
Level 2: A proportional–integral–derivative controller (PID controller) based system;
Level 3: A programmable logic controller (PLC) based system.

Automation & control system in re-heating furnace ensures the following:

- ✓ Maintains proper temperature regime across the length of the furnace.
- ✓ Maintains air-fuel ratio including correct amount of excess air.
- ✓ Maintaining correct furnace pressure and draught.

Re-heating furnace automation & control system consists of following monitoring instruments-

1) Thermocouples of measuring temperatures.
2) zirconium based online oxygen analyzer to measure the oxygen percentage in flue gas
3) pressure transducers to measure the furnace pressure
4) control instruments like Variable Frequency Drives in FD and ID fan
5) solenoid valves in air and fuel line
6) Motor driven screw feeder and a control circuit



All instruments & control setting are installed in a closed loop. Feedback from the monitoring instruments are received by the control circuit & controls parameters for optimize the furnace efficiency.

Justification of technology selection:

The proposed technology of automation and control system in furnace not only helps to monitor and analyze various furnace parameters but also can improve the efficiency of furnace through effective monitoring and control of air-fuel ratio; controlling furnace draft; maintain optimum fuel feed based to control the coal flow.The improvement envisaged through the installation of the system has been summarized in the table below:

Table 3: Performance parameters of re-heating furnace

Parameter	Current Operation	Ideal Operating Scenario	Present Scenerio	Post Implementation scenario
Stack Oxygen %	Currently Oxygen percentage in flue gas was 9.4% ,no oxygen monitoring system available	Stack oxygen will be maintained 7% based on the fuel used for optimized combustion	Higher stack oxygen will result higher heat loss as excess air carrying heat	FD fan and feeder auto control based on flue gas pressure, which maintains the stack oxygen within standard limits.
Draft Pressure	Not measured online	-0.1 mmWC (Auto control)	Positive draft pressure causes back-fire and more negative draft pressure results in	Draft pressure should always be slightly negative

			fuel unburnt	
Burning Loss	3.0%	0.8% to 1.5%	More product loss	Product losses will reduce & quality improve.(skin temperature will reduce due to reduce oxydation)

Estimated Energy & monitoring saving:

As mentioned in the earlier segments, the furnace capacity at Howrah rolling units vary from 2.5 tph to 20 tph. For calculating the energy and monetary benefits, a represntative case of boiler of 10 tph capacity has been considered. The benefits envisaged through installation of furnace automation and control system has been summarized in the table below:

Table 4: Cost benefit analysis for furnace automation system

Parameters	UOM	Values	
		Present	**Proposed**
Average temperature of flue gas	^{o}C	670	670
Present temperature of inlet air	^{o}C	35	35
Proposed oxygen level in flue gas	%	9.40	7.00
Excess air	%	81	50
Theoretical air required to burn 1kg of fuel	kg	6.99	6.99
Total air supplied	kg/kg of fuel	12.66	10.49
Weight of flue gas	kg/kg of fuel	13.66	11.49
Rise in temperature	^{o}C	635	635
Specific heat of flue gas	kcal/Kg ^{o}C	0.24	0.24
Sensible heat loss in flue gas	kcal/kg of fuel	2,081	1,751
Saving in flue gas loss	kcal/kg of fuel	-	331
% Saving per kg of fuel	%	0	15.89%
Annual fuel consumption	kg/y	1,390,922	1,390,922
Heat loss per year	M kcal/y	2,896	2,436
Saving in flue gas loss	M kcal/y	-	460
GCV of fuel	Kcal/kg	5,600	5,600
Efficiency of furnace	%	20.64	20.64
fuel Loss due to high excess air	kg / y	2,505,238	2,107,214
Saving in fuel	kg / y	-	398,024
	t / y		398
Cost of fuel	Rs / kg	7.62	7.62
Monetary savings per year (A)	Lakh Rs / y		30.4
Furnace output	t/h	5.36	5.36
Burning Losses	%	1.5	1.35
Reduction in burning losses	%	10.0	
Saving in raw material	ton/h	54	
Cost of Raw materials	Rs /Ton	17000	
Monetary Saving as per (B)			
Raw material savings	t/y	103	

Cost of raw material (B)	Rs/t	20.63
Annual monetary savings (A+B)	Lakh Rs/y	71.60
Estimated investment	Lakh Rs	12
Simple payback period	Months	2

* extracts of calculation provided

The benefits can be summarized as:

- ✓ 25-30 % reduction in specific fuel consumption
- ✓ 1-2 % reduction in burning losses

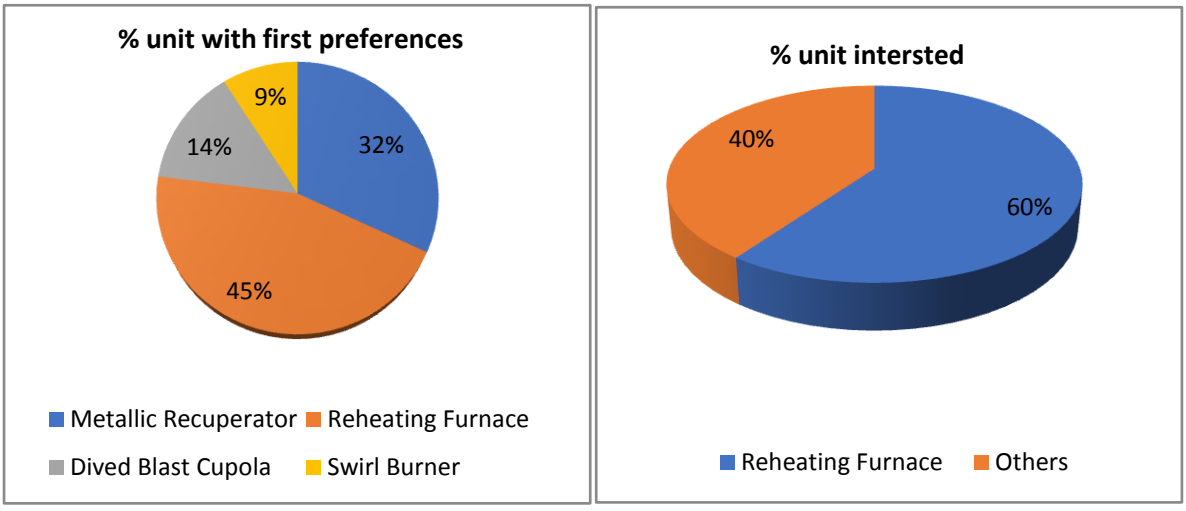
Replication Potential:

Howrah has a large number of rolling mill units. The steel Rolling Mills Association (SRMA) is the biggest association for rolling mills and some local associations like Howrah chambers of commerce and Industries (HCCI) and Durgapur rolling mill association are 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 reheating furnace automation has huge demand, with 27 out of 100 surveyed units so far, showing interest for the technology. However, while analyzing the preference of the units on the list of technologies.

Figure 1: Summary of survey results



As seen from the above, 45% of the units out of 80 surveyed units, has opted for 'reheating furnace automation' 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 20% in the cluster, i.e. 20 units. Based on 20% replication, the overall project benefits will be as follows:

Table 5: Impact of replication of technology

Parameter	UoM	Value
Annual thermal energy saving (one unit)	t/y	398

Annual thermal energy saving (one unit)	MJ/y	9,330,311
Annual material saving (one unit)	t/y	103
Annual total energy savings	MJ/y	9,330,311
Annual coal saving (considering 20% replication)	t/y	7,960
Annual energy saving (considering 20% replication)	MJ/y	186,606,216
Annual CO_2 emission saving (one unit)	tCO2/y	842
Annual CO_2 emission saving (considering 20% replication)	tCO2/y	16,844
Estimated investment in technology (one unit)	Rs in Lakh	12
Estimated investment in technology considering 20% replication (assuming price down due to demand aggregation)	Rs in Lakh	240
Annual CO_2 emission saving (in 10 years)	tCO2/y	168,444

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:

The technology of Automation and Control system in furnace 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:

- ✓ Resonant Energy Solutions, Raipur, Chattishgarh
- ✓ Bosh Limited , Kolkata
- ✓ BML Control Instruments Pvt. Ltd, Kolkata
- ✓ Technotherma Furnaces, Mumbai
- ✓ ENCON Thermal Engineers Pvt Ltd, Faridabad, Hariyana
- ✓ ACI Automation Pvt Limited, Chennai