

# Investigation of Pollution Emits By Cupola Furnace in Gujarat Foundry

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**Abstract-** The foundry industry is the major contributor in pollution among all other industries in India. At present only few foundries in India have pollution controllable system. Most of these casting industries use cupola furnace that emits gases namely carbon dioxide, carbon monoxide, nitrogen dioxide, sulphur dioxide, suspended particle matter, dust and ash. Though, emission from single furnace is not considerable but it has huge impact if much such type of furnaces located in particular area. A inclusive study on the type of gas emitted, rate of gases and amount of pollution cause from cupola furnace is essential before design any emission controlling system. In this paper investigation on furnace wastages is carried out on GIDC (Gujarat, India). The outcomes of research are based on data taken out from cupola furnace where the pollution measuring system was set up. The rates of emission of gases are measured hourly for a whole day and it has been noted that in very first hours of firing the emission was at peak. It also been noted that pollution from this furnace was much higher than decided pollution range by the Gujarat pollution control board (GPCB). There are some alternatives of such furnaces are also suggested.

**Keywords:** cupola furnace, rate of emission, pollution, control system, foundry industry

## I. INTRODUCTION

Today pollution has become big challenge around the globe. In order to reduce pollution government, society and industries have to work together. In this paper industrial pollution has been measured. Among all different Industries the most polluting industrial sector is foundry sector. The foundry industry has to move from cupola furnace to the induction furnace in order to decrease emission and wastages. Although, the prior one is cause of air pollution but it is very economical and fundamental unit for casting industry. On one side many big foundries have good sources such as manpower and assets. On the other side; small and medium scale foundries struggle to manage enough funds, effective technology, additional electricity, water and skilled human resources. These problems of many foundries results in less effectiveness and compatibility of furnace. If we consider impact of emission from single farm it is very low but effect from all sectors could be major. Cupola furnace fuel emits carbon monoxide, dust, carbon dioxide, nitrogen dioxide, sulphur dioxide, suspended particulate matters (SPM) and ash. Almost all Indian foundry industries have cupola furnaces with minimum technology set up to reduce emission. In this research paper the alternative control system to ease air pollution caused by cupola furnace and some basic problems

related to air pollution are discussed. The studies were carried out at Gujarat foundry industry.

## II. METHODOLOGY

Procedure and material used in cupola furnace:

Cupola furnace is very basic model of furnace. A huge cylindrical shape made from steel and inner layer covered with bricks in order to deal with radiation leakage. It can be described in three zones. The top zone of furnace is filled with raw materials like iron scrap or steel scrap. The middle zone of furnace is hitting center. Here coke is used to melt the scrap of iron or steel also right amount of air is passed through this furnace with the help of tuyeres for proper ignition. And at bottom zone this melted iron or steel is collected in liquid condition.

Size and approximate melting rate of the cupola:

Height of cupola in meter: 11

Diameter of cupola in meter: 1.45

Rate of Melting in casting: 5-6(MT/hr)

This is a cast study on a single foundry. The investigation is carried out on cupola furnace at GIDC (Gujarat Industrial Development Corporation). Initially, in order to check per day pollution data were collected end of the day. After that, data were collected on hourly bases to study rate of change of emitted gases per hour. Pollution measuring machine was used during this investigation.

## III. LITERATURE REVIEW

Mukhargee(2011) have give solution for pollution caused by cupola furnace, According to him cleaner production can maximize efficiency of furnaces but there are many barriers towards cleaner production. His study conclude that the foundry industry “Could not ensure proper utilization of energy and the control of emission”

Baukal(2004) has compared process modification and combustion modification. The both modification can control pollution and improve efficiency of burner. The process modification includes both by using high quality substitute of row material of modified end product. Combustion modification includes the proper maintenance of burner or using clean gases to improve the thermal efficiency

Charles E. Baukal, et.al. (2004) here author discusses that Pre treatment process by modification of row material or the firing system. The row material can be modified by removing sulphur in pretreatment. And the post treatment refer that reducing the emission before it emits to the environment

Ronald J. Frundl (1970) According to author afterburn can speed up process and help to complete combustion of fuel, this will result in improve the efficiency of cupola furnace , but it also has some drawbacks , these includes long process time , additional equipment and these leads to some capital investment.

E.M.Emmima et-at,(2004) discussed role of management of the organization towards environment. According to him management mast follows the legal rules n regulation of pollution control board. Therefore they should plan a system which deals with quality of furnace, environment issue, and risk. This management also should be responsible to control environment hazards such as pollution to air, water pollution and waste emitted by cupola furnace.

Thareja(2012), in his work emphasis on implement of environment management system(EM)., According to his view point foundry with new technology might not have improve performance also organization need experience and educated workers to operate these technology. Thus foundry should have EMS to train work force and introduce the new technology and its benefits moreover this EMS impose and follow environment rules and regulation.

**IV. DATA COLLECTION**

TABLE 1 Data collection from the cupola furnace at GIDC

Sr no	Source	pollutant			
		SPM $\mu\text{g}/\text{m}^3$	NO <sub>2</sub> $\mu\text{g}/\text{m}^3$	SO <sub>2</sub> $\mu\text{g}/\text{m}^3$	CO $\text{mg}/\text{m}^3$
1	Cupola Furnace	1829.9	171.4	42.5	5.87

TABLE 2 Concentration of (SPM) in cupola

Sr no	Melting rate (Kg/Hr)	Conc. of SPM (mg/Nm')
1	40-50	2646
2	35-40	791
3	35-40	728

TABLE 3 Concentration of sulphur dioxide (mg/Nm) in cupola emissions

Sr no	Melting rate (Kg/Hr)	Conc. of SO <sub>2</sub> (mg/Nm)
1	40-50	402
2	35-40	198
3	35-40	188

TABLE 4 Concentrations of co and co2 in cupola furnace emissions

Sr no	Conc. of carbon monoxide		Cone, of carbon Dioxide (%)
	(gr/Nm <sup>3</sup> )	(%)	
1	50.43	4.03	5.7
2	58.59	4.55	6.4
3	61.21	4.93	8.5

TABLE 5 Comparisons between cupola furnace emission standard with GPCB standard

Sr no.	Cupola furnace emission standard	Gujarat pollution control board standard
1	SOM = 1829.9	1500
2	NO <sub>2</sub> = 171.4	150
3	SO <sub>2</sub> = 42.5	30 (corrected at 12% CO <sub>2</sub> )
4	CO = 5.87	1% max

**V. ANALYSIS**

During combustion in furnace many harmful gases produces. These gases are suspended particle matter, carbon dioxide, carbon monoxide, sulphur dioxide, dust, fly ash, etc. However it needed to be control. The table 1 shows the pollution reading of whole day from cupola furnace. It has been noted that starting temperature of cupola furnace is 200°c and coal is used as fuel. For the combustion in coal, oxygen is passed with the help of blower. The pollution measuring machine was set up in order to take reading. Iron is used as raw material.

Form the table 1 it is clear that the maximum emission is of suspended particle matter during the cupola operation. The gas rate of SPM 1829.9  $\mu\text{g}/\text{m}^3$  and followed by the NO<sub>2</sub> 171.4  $\mu\text{g}/\text{m}^3$  And SO<sub>2</sub> 42.5  $\mu\text{g}/\text{m}^3$ .

Tables 2, 3, 4 represents that during very 1<sup>st</sup> hour of combustion pollution was highest. Among the all gases the suspended particle matter has maximum amount of emission in the environment. This rate was 2646 (mg/Nm). The second most emission was of sulphur dioxide that was 402(mg/Nm).

Here table 5 provides comparison between rates of emissions from cupola furnace with suggested level of pollution by Gujarat pollution control board (GPCB). The outcome of comparison reveals the fact that the foundry pollution is above the limit range of GPCB. In order to control pollution caused by Cupola furnace, it is necessary to improve performance of cupola furnace.

**VI. DISCUSSION**

According to “D. E. Clark(2002)” “the emission of foundry is depends on (1) Iron coke ratio (2) Temperature (3) Specification blast rate (4) Diameter of Cupola furnace (5)

Coke characteristics (6) condition of return scarp (7) Method of charging.” During the operation of cupola furnace many mistakes are noted, first instead of ordinary coal, high quality of coal can be used. The amount of oxygen and carbon is comparatively high in good quality of coal. These better qualities of fuel increase efficiency of cupola furnace as complete combustion take place, therefore no need to afterburn which lengthens time of process. Also gas can be used as fuel. As during the combustion of gas less harmful substance are emitted. Furthermore diameter and height of cupola furnace is taken in consideration. Some simple modification in cupola design can improve efficiency of furnace. Also some basic and economical pollution control devices can be added to design of furnace. This modification leads to overall less emission and bring down pollution under the range of Gujarat pollution control board.

Using above strategies and recommendations foundry industries may build up eco-friendly casting.

## VII. CONCLUSION AND RECOMMENDATIONS

1. Result of study at GIDC reveals that the pollution from cupola furnace is much higher than settle on range of pollution by Gujarat pollution control board. It is necessary to reduce the emission of harmful gases and so pollution level by using appropriate substance.
2. It is also essential to improve design of cupola furnace to make it efficient and set gas cleanout units that are able to reduce dangerous gases.
3. Moreover shaft height requires main attention. To adjust this height, ratio of height and diameter of cupola needs to be appropriate. This would help to produce proper combustion in raw material and increase efficiency of furnace. Also measurement of change door should be taken in to account while designing the cupola furnace. This will help to reduce emission of harmful carbon monoxide, nitrogen dioxide; carbon dioxide and it also help to settle down large particles of suspected particle matter.
4. Energy efficiency is one more factor to consider this can be solved by installing the dived blast cupola design instead of normal cupola furnace. This will improve overall efficiency of furnace and reduce harmful emission.
5. Scrubbing gases with appropriate wet scrubber is one more solution. Different kind of venturi scrubbers can be used as these types of scrubbers have 99% working efficiency and set up cost is moderate. Moreover, change in any particle size does not affect working efficiency of this type of scrubber. Therefore concentration of SPM in harmful emission of gases is unlike to vary with the any changes in the characteristics of input raw substance which is common in such type of foundry industry. Nevertheless gas cleaning method needed to be employed where it is difficult to get enough water for process.
6. Results of data collection indicate that CO emission is very high immediately after firing the fuel as temperature of gases is above 200°C throughout this period.

Although, air is passed through charge hole but instant combustion of carbon monoxide might not happen. At this stage, it is essential to enter afterburner to speed up combustion process.

7. Lastly some simple modification in cupola design can improve efficiency of furnace. Also some basic and economical pollution control devices can be added to design of furnace. This modification leads to overall less emission and bring down pollution under the range of Gujarat pollution control board. Using above strategies and recommendations foundry industries may build up eco-friendly casting.

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