# Investigation Of Air Emission Control System In Indian Foundry

**G. S. Patange [1], M. P. Khond[2], S. J. Prajapati[3], H. J. Rathod[4]**

[1,3,4] Charotar University of science and technology, Changa – 388421, Gujarat, India

[2] College of engineering, Pune Maharashtra – 411005, IndiaCorresponding author

## ABSTRACT

This paper describes need of air pollution control in a foundries in india.Most of foundries are not aware of the air pollution in a foundry though Presently environmental problems of casting production in small-scale foundry sector are gaseous emission. Promotion of cleantechnology towards cleaner production has achieved significant in many countries .

But that technology was not widelyaccepted due to unawareness of realization of the scenario. The study revealed that there is a need of implementation of cleaner production technology in foundry sector in india because of share of production of this sector.Objective of this paperis to give suggest the model for control the emission in medium and small scale foundries.



***KEYWORDS:***foundry, cleaner production,sources of emission, air emission, air emission control system.

## INTRODUCTION

Air pollution by waste smokes, fumes and dust in a foundry has become a problem of vital importance. On our planet about 2 billion tons of metalliferrous and non minerals are processed every year.

This is accompanied by the liberation of 200-250 million tons of aerosols and up to 250 million tons of sulfur dioxide besides a large amount of other harmful substances that pollute the atmosphere.

To combat the problem of pollution , a multidirectional approach is called for effective measures need to be adopted to reduce the quantity of the pollutants generates , whenever it is possible. .

Recycling of the waste gas and a sound waste disposable system can ensure a cleaner environment**.** It includes a characterization of the industry, an overview of the different process types, a description of emissions, and a description of thetechnology used to control emissions resulting from Foundries. **[3]**

## SOURCE OF EMISSIONS AND POLLUTANTS FROM VARIOUS WORK AREAS IN A FOUNDRY

In foundries,various processes are used for molding, melting and casting. These are accompanied by liberation of heat, noise, dust, fumes and gases. The details of various emissions and pollutants from various work areas in a foundry are explained as under:

- Pattern shop
- Sand preparation section
- Molding and core making section
- Metal furnaces
- Knockout section
- Fettling shop
- Heat treatment furnace

**Pattern Shop**In pattern shop where wood working machineries are installed a local exhaust system to capture the sawdust and wooden chips should be provided. Normally, a mechanical type of dust collector like cyclone is sufficient to remove the particulates. The swaps, planers and drills may have built up hoods which require only a dust collection. [4]



**Sand Preparation**Section The molding and core sands in foundries are prepared in sand mixtures of various designs. The ingredients mixed are also different at different times. Fly ash, dusty materials, micro-fines metallic and non-metallic oxides are the commonly produced pollutants in this section [4]

**Molding and Core Making Section**The pollutants generated in the molding and core sections contain mainly dust. However the amount of dust generated is much less as compared to other sections. Harmful substances such as carbon monoxide and sulphur dioxide are evolved while drying moulds and cores.

The above depend on the type of fuel and the quantity of the same consumed during drying moulds and cores[5].

**Metal Furnaces**The particulate emissions from a cupola furnace may be of three types. They are metallic oxides, silicon oxides and calcium oxides .The actual amount of each constituents depend on the type of material used, the lining quality and its operating conditions.

The gaseous emissions from the cupola furnace are composed of carbon dioxide, which is due to incomplete combustion of carbon.

Sulphur is introduced in the exhaust gases as sulphur dioxide, because of its presence in coke and metallic charge.

Arc furnaces emit large amount of pollutants such as dust, carbon monoxide, oxides of nitrogen and sulphur, and cyanides along with process gases. The amount of these gases depends upon the raw material used and the manufacturing process and the exhaust system for gases[6].

**Knockout Section**In steel foundries, knocking out of the castings out of the mould boxes is most detrimental to the health because of the evolution of the harmful vapors, gases and dust containing approximate 68% of particles of size approximately 2 micrometer in diameter and 32% for 2 to 10 micrometer.

However the presence of hydro cleaning chambers can be the preventive measure in this section[5].

**Fettling Shop**Following the knock out the casting usually requires further cleaning depending upon the type and size of casting involved and this may be done by grinding, abrasive blasting, tumbling barrels, chipping, sawing and cutting. Welding operations for repair of casting should be done under controlled conditions[7].

**Heat Treatment Furnace**The main pollutants in gases from heat treatment furnaces are carbon monoxide and sulphur dioxide. The gases are normally discharged into the atmosphere through high stack that will facilitate dispersion of sulphur dioxide into the upper atmosphere and will reduce its ground level concentration within permissible limits[7].



## CONTROLLING METHODS IN FOUNDRIES FOR AIR EMISSION.

There are two primary collection methods for foundry particulates - wet and dry. Wet scrubbers include low- and high-energy types. Dry collection includes bughouses, mechanical collectors, and electrostatic precipitators. In addition, to control emissions of organic compounds, incineration or afterburners may be required. Air toxics merit special consideration,requiring careful selection of the emission control method.

- **WET SCRUBBERS**

For particulate collection, the mechanisms used in a wet-type collector are inertial impaction and direct interception. These are used either separately or in combination. In studying wet collector performance, independent investigators developed the contact power theory, which states that, for a well-designed wet-scrubber, collection efficiency is a function of the energy consumed in the air-to-water contact process and is independent of the collector design.

On this basis, well-designed collectors operating at or near the same pressure drop can be expected to exhibit comparable performance. All wet collectors have a fractional efficiency characteristic that is, their cleaning efficiency varies directly with the size of the particle being collected. In general, collectors operating at a very low pressure loss will remove only medium to coarse particles.

High-efficiency collection of fine particles requires increased energy input, which will be reflected in higher collector pressure loss. In addition to particulates, gas scrubbers may be used to control odors and toxic and sulfur dioxide emissions. In this case, acids, bases, or oxidizing agents may have to be added to the scrubbing liquid. Disposal of this stream is subject to effluent guidelines for metal molding and casting **[2].**

## ➢ B. DRY COLLECTORS

The most frequently encountered equipment for the removal of solid particulate matter from an air stream or gas stream is the fabric dust collector or baghouse.

With a mass median size of 0.5 µm, a collection efficiency of 98-99+% can be expected. As the filter medium becomes coated in a fabric collector, the collection efficiency rises. However, as material continues to build on the bag surface, higher pressure drops occur, which result in a significant reduction inairflow.



To maintain design flows, the bags must be cleaned periodically by mechanical shakingor with pulsed air.

Filter media are now available for hot corrosive atmospheres, such as furnace emissions. Operating inlet temperatures up to 500°F (260°C) are not uncommon. High humidity can be a problem if no provision is included for the condensation of free moisture.

Free moisture and acid dew point are the worst enemies of all fabric collectors. It is important to have the following design information in order to select the proper fabric and the quantity of bags required:

- Gas flow rate
- Temperature and dew point
- Acid dew point
- Particle size and distribution
- Concentration of solids
- Chemical and physical properties of solids

Teflon-coated, woven glass-fiber bags have been used on a large majority of cupola installations because of their high temperature resistance. If fluorspar is used, Named bags, which are acid-resistant, but combustible, are generally installed.

The temperature of the gasesentering the bughouse then must be reduced to a maximum of 400°F (204°C). Use of these lower-temperature bags creates a potential corrosion hazard because of the acid dew point problem.

For reverse-air and mechanical shake collectors, air-to-cloth ratios range from 1.5- 2.5:1. Pulse-jet and cartridge collectors also can be used to collect pollutants from sand systems and casting cleaning operations. With either type of unit, care must be taken to select the proper air/cloth ratio (maximum of 25:1 with pulse jet and 1.5:1 with cartridge).

In general, these types of collectors will have only marginal results with furnace and inoculation emissions. If considered, they should be employed at a very low air/cloth ratio. In addition, moisture introduced with compressed air may be significant and cause system failure. **[2]**

- **INCINERATION**



Afterburners may be used in some processes to control emissions, particularly when oily scrap or hydrocarbons in any form are charged into the furnaces or scrap preheat systems.

Afterburning is required for below-the-door cupola emission systems. If afterburners are not used, carbon monoxide and oil vapors may be emitted through the discharge stack of the air pollution equipment.

In order to achieve the required incineration, sufficient retention time (aminimum of 0.6 second) and ignition temperatures must be maintained. In general, in the selection of collection devices for all processes, moisture, temperature, andthe presence of corrosive materials must be considered.

The temptation to operate at higher air/cloth ratios in bughouses must be avoided. Similarly, claims that lower pressure drops in scrubbers create high efficiencies have been proved.

Incineration involves the high efficiency combustion of certain solid, liquid, or gaseous wastes.The reactions may be self-sustaining based on the combustibility of the waste, or may requirethe addition of auxiliary fuels, such as natural gas or propane.

They may be batch operations or continuous as with flares used to burn off methane from landfills. When not burning solids, they are also called thermal oxidizers, and these devices can operate at efficiencies of

99.99% (as with hazardous waste incinerators).figure 1 **[2].**

ISSN: 2278-0181
Vol. 2 Issue 5, May - 2013

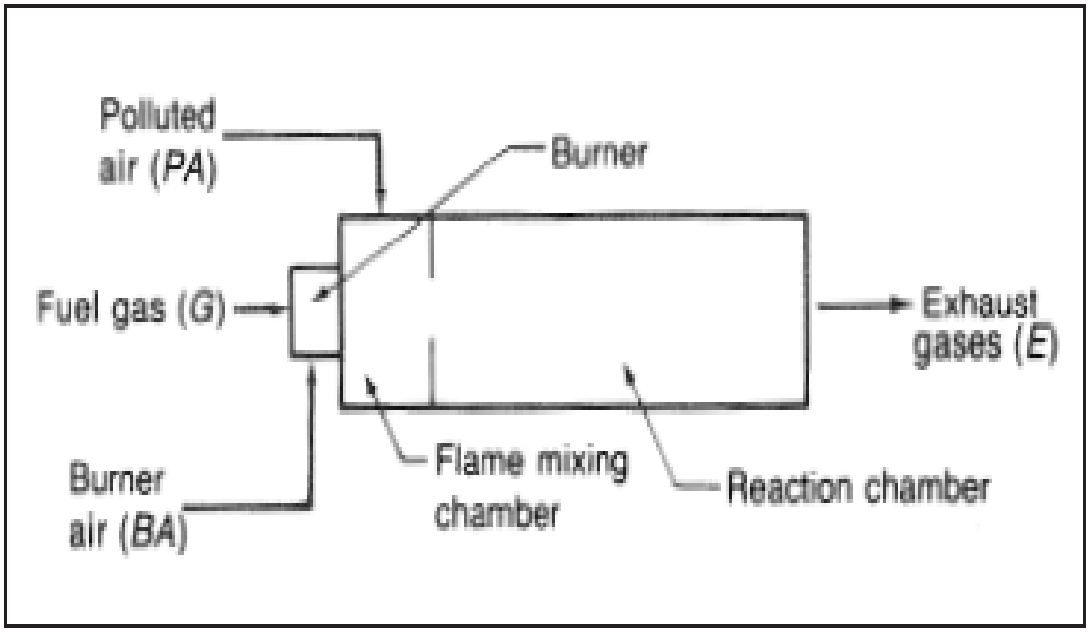



***Figure. 1***



- **ADSORPTION**

Charcoal adsorption has been used in conjunction with other control devices for VOC control**[2].**

- **FILTER**

Filters serve for removing the particulate matter from gas or air streams by retaining it in or on the porous structure through which gas flows. The porous structure is usually a woven fabric. The filter must be continuously or periodically cleaned or replaced.

Filters are commonly employed in pattern shops on various wood working machines. They are also used on cupola collection systems in conjunction with equipments like after burners, gas coolers and exhaust blowers.

Sand reclamation plants also use bag house filters for separating fines from sand grains**[2].**

- **CYCLONES**

The cyclone works on the principle of centrifugal separation in which a vortex motion of the particulate matter is created within the collector. This motion provides the centrifugal force that propels the particles to location from where they may be removed. Besides, they may either deposit the matter in a hopper or concentrate it into a stream of gas that flows to another separator for ultimate collection shown in figure 2.**[2]**

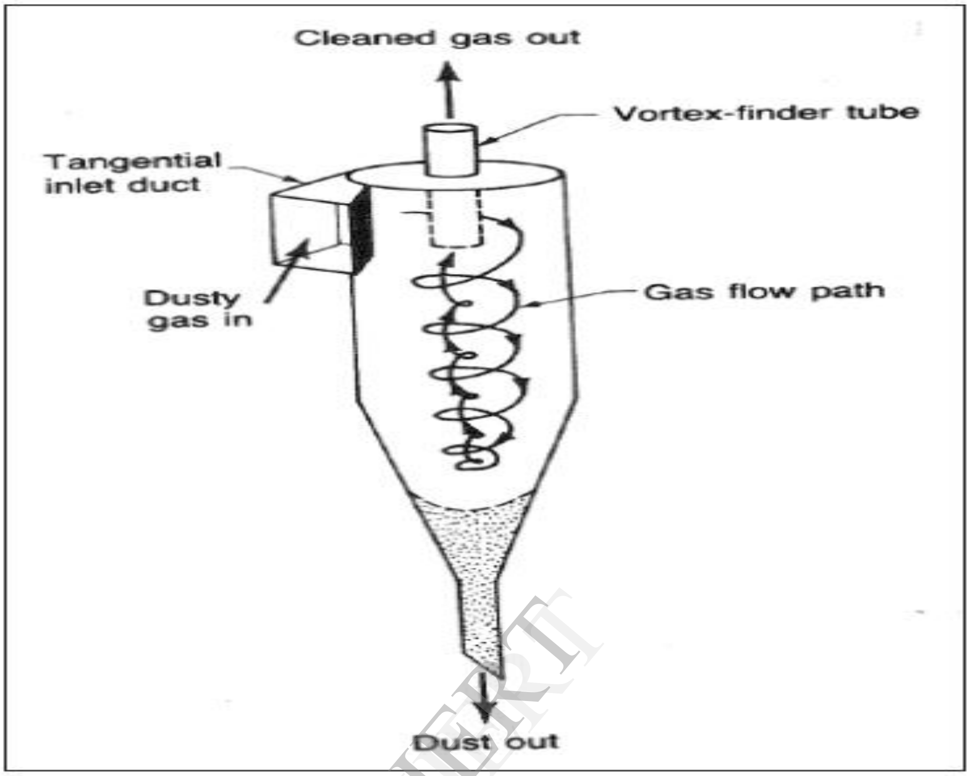



*fig 2 cyclones*



- **COMBINATION DEVICES**

Some devices combine features of the above mentioned equipments, so dust and fumes are controlled most economically and with a minimum pressure drop.

There are cyclones in which liquid is sprayed and scrubbers in which cyclonic actions are used. Packed bed filters and scrubbers are similar to each other the only difference being that the equipment designed to separate particulate matter is called a “FILTER”, and the same when designed to separate gaseous contaminants is called as a “SCRUBBER”. **[2]**

## MONITORING OF AIR POLLUTION

In order to monitoring air pollution , sampling of air is done in which representative sample of air is collected and then analyzed to exactly determined  the concentration of pollutant to the general hody of air .

The method used for determining gaseous emissions from a stack or a vent depend on the nature compound and the purpose for making the measurement. In addition of the composition and the temperature carrier gas stream affect the selection of a sampling technique, analytical method and the sampling plan.**[3]**

## COMPARISION OF AIR EMMISSION DATA IN DIFFERENT FOUNDRY

| Sr | Source | Pollutant | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | SPM(µg/m$^3$) | | | NO2(µg/m$^3$) | | | SO2(µg/m$^3$) | | | CO(µg/m$^3$) | | |
| | | F1 | F2 | F3 | F1 | F2 | F3 | F1 | F2 | F3 | F1 | F2 | F3 |
| 1 | Furnance operation | 1829.9 | 1000 | 600 | 171.4 | 1100 | 800 | 42.5 | 35 | 22 | 5.87 | 3.25 | 1.5 |
| 2 | Prepration of cores and moulds | 3919.4 | 2012 | | 95.2 | 70 | 55 | 489.5 | 225 | 200 | 2.38 | 1.02 | 2.0 |
| 3 | Casting | 1012 | 800 | 300 | 722 | 450 | 300 | 402 | 250 | 200 | 4.03 | 2.3 | 1.3 |
| 4 | Shakout and reclamation | 700 | 450 | 200 | 430 | 300 | 250 | 320 | 200 | 150 | 2.12 | 2 | 1.6 |



## COMPARISION BETWEEN DIFFERENT COLLECTING DEVICES

| SR NO | Point of comparition | Cyclone seperator | Filters | ESP | VENTURI SCRUBBER |
|---|---|---|---|---|---|
| 1. | Capital cost | Low | High | Very high | moderate |
| 2. | Running cost | Low | High | Very high | moderate |
| 3. | Power consumption | Moderate | moderate | Very high | high |
| 4. | Particulate | ≥6.5µm | ≈0.1 µm | ≈0.001 µm | >2 µm |
| 5. | Characteristics of particulate matter contaminants | Coarse dust (solid) | Fine particulates (solid +liquid) | Very fine gaseous particulates contaminants | |

## FACTOR INFLUENCING SELECTION OF COLLECTING DEVICE

- size, shape and density of particulate matters to be collected.
- Dust load of the flue gas (dust load is expressed in $g/m^3$)
- Efficiency of the collecting device.
- Flow characteristics of the flue gas(gas flow rates and its fluctuation).
- Property of the flue gas(composition, temperature, combustibility, pressure , acidity, alklinity, toxycity etc.)
- Characteristic of the particulate matters present in the flue gas.(phase- solid, liquid or gaseous, combustibility, composition, toxicity etc..)
- Possible drop in pressure in the device.
- Disposal of the waste generated by the pollution control equipment.
- Cost of installation and cost of operation.
- Maintainability and reliability.

## SUGGEST THE POLLUTION CONTROL SYSTEM



Several methods are available to clean exhaust gases. In This system include cyclone separators, fabric filters,dust collector and efficient venturi scrubbers.

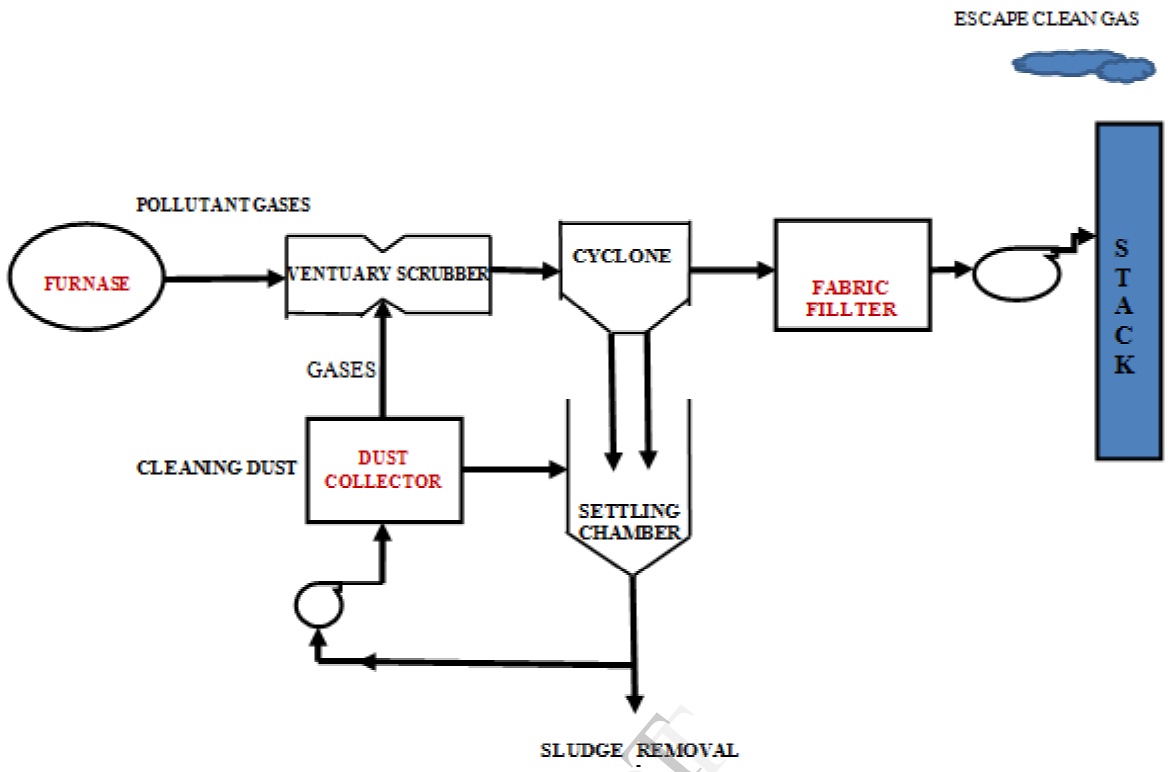
We have to suggest this is efficient model to reduction for air emission in the foundry. and helpfull to make a clean environment.

This system are control the critical parameter $NO_2$ ,$SO_2$,co and suspended partical matters.The remaining gas, now dry and cleaned of almost all particulate matter, before to escape through the chimney

There is a substaintional potential for growth and technology up gradation in this sector. Combustion study and fuel economy measure, installation of this control system to prevent air pollution would go a long way in improving the competitiveness of this sector of industry.

The work can be carried out to focus on implementing this model helpfull to minimize ,treat and dispose air emission.

This control system to prevent the air pollution would go a long way in improving the competitiveness of this sector of foundry. And make the process more efficient and cleaner environment.Shown in figure 3.




*fg 3 Combine pollution control system*



## DISCUSSIONS AND COLCLUSION

Foundries are energy intensive industry.They also fair share in generating fume And dust forthe environment.

Judious selection of control system ,control parameter and some of the innovations in this model and produce a cleaner environment.Even though our study specifically focuses on a particular plant, the results may be interesting on reducing of air emissions.


## ACKNOWLEDGEMENTS

The authors' wishes to thank research paper review committee, department of mechanical engineering. Principal and dean faculty of technology and engineering, Charotar University of science and technology, changa for their suggestions, encouragement and support in undertaking the present work.

Special thanks to the management and ABC private limited company for their moral support and continuous encouragement.

## REFRENCES

1. Air and Waste Management Association. Air Pollution Engineering Manual. New York: Van Nostrand Reinhold, 1992.
2. Method for Reducing Pollution in Foundries - International Minerals and Chemical Corporation[2]
3. Dr. G L DATTA , air pollution measurement & control in foundries.
4. Air pollution control equipment, foundry equipment from GMD Environmental Technologies, INC
5. Method for Reducing Pollution in Foundries - International Minerals and Chemical Corporation
6. Method of Handling and Cooling Foundry Sand by Schumacher
7. TERI - Energy-efficient cupola and pollution control system for foundry units, The Energy and Resources Institute Creating Innovative Solutions for a Sustainable Future
8. R P Subramanian, Towards Cleaner Technologies A process story in small-scale foundries.
9. Environmental ,health and saftey Guideline foundies.