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Air Pollution Monitoring & Control at Foundry Clusters in Belgaum-A Case Study

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Abstract
Foundry in Belgaum is the only relatively modern. A foundry is a casting manufacturing system. Casting is the process of forming objects by pouring liquid metal into prepared mould and allowing the melt to solidify. The foundry operations generate different kinds of air pollution, depending upon the kinds of furnace in use and the kinds of energy inputs that they use.The present study indicates the air pollution concentration of foundry clusters area of Belgaum city divided in three zones and the concentration of different air pollutants such as Sulphur dioxide (SO2), Nitrogen dioxide (NO2), Ammonia (NH3), Particulate Matter 10 (PM10) and Particulate Matter 2.5 (PM2.5) are analyzed. Monitoring locations were divided in three zones Udyambag, Angol, Machhe sampling was done for 24 hours duration. The samples were collected during the month of January February, March and April 2014.

INTRODUCTION

Foundry is well famous, very old and very concur-rent and efficient production process. Besides, casting of metal is very complex process, because of com-pounding of great number of variables that must be con-trolled. If it is added, that demands bringing the techno-logical process of casting in context of environmental protection, because of the fact that the process is significant pollutant, respecting the advances and mistakes of the process.
Harmful emissions caused by casting melting and production are basically related to the use of additives and fuels or raw material impurities. The use of coke or oil might cause the emission of the product of burning. The use of additives in the process generates a reaction. The presence of impurities in waste that blend by melting may cause the formation of a product with incomplete combustion or a recombination and dust. Dust from the process might consist of metal and metal oxides. During the melting process, elements evaporate and tiny metal dust particles are released. Metal particles appear during the final Processing. [4]

FOUNDRY INDUSTRY – BELGAUM [4]
Belgaum is a pioneer in the development of Foundry Industry sector in Karnataka, which has the influence of Kolhapur, Pune, and Mumbai (in Maharashtra) due to earlier development of automobile and mechanical industries in those areas. Over a period of four decades, the foundry industries in Belgaum has not grown to the expected level due to the lack of infrastructure facilities, advanced testing facilities, and pollution-related International Conference on Technology and Business Management problems. Belgaum exports variety of castings to various countries both directly and through export agents. Foundry forms one of the major industrial sectors of Belgaum. It is also one of the major economies of Belgaum. There are 142 foundries at present in Belgaum, out of which 76% is small scale, 21% are medium scale & 2% are large scale foundries. The Belgaum foundries produce different types of casting ranging from 500gm to 1.8Tons. The major raw material required for foundries are sand (washed & unwashed), resin & alloys. The major loss that is incurred by the foundries is the wastage of sand as about 10-10,000Tons of sand is wasted while transporting.

LITERATURE REVIEW

2.1 FOUNDRY

Foundry is a factory which produces metal castings from either ferrous or non- non-ferrous alloys. Metals are turned into parts by melting the metal into a liquid, pouring the metal in a mould, and then removing the mould material or casting. The most common metal alloys processed are aluminium and cast iron. However, other metals, such as steel, magnesium, copper, tin, and zinc, can be processed. [3]

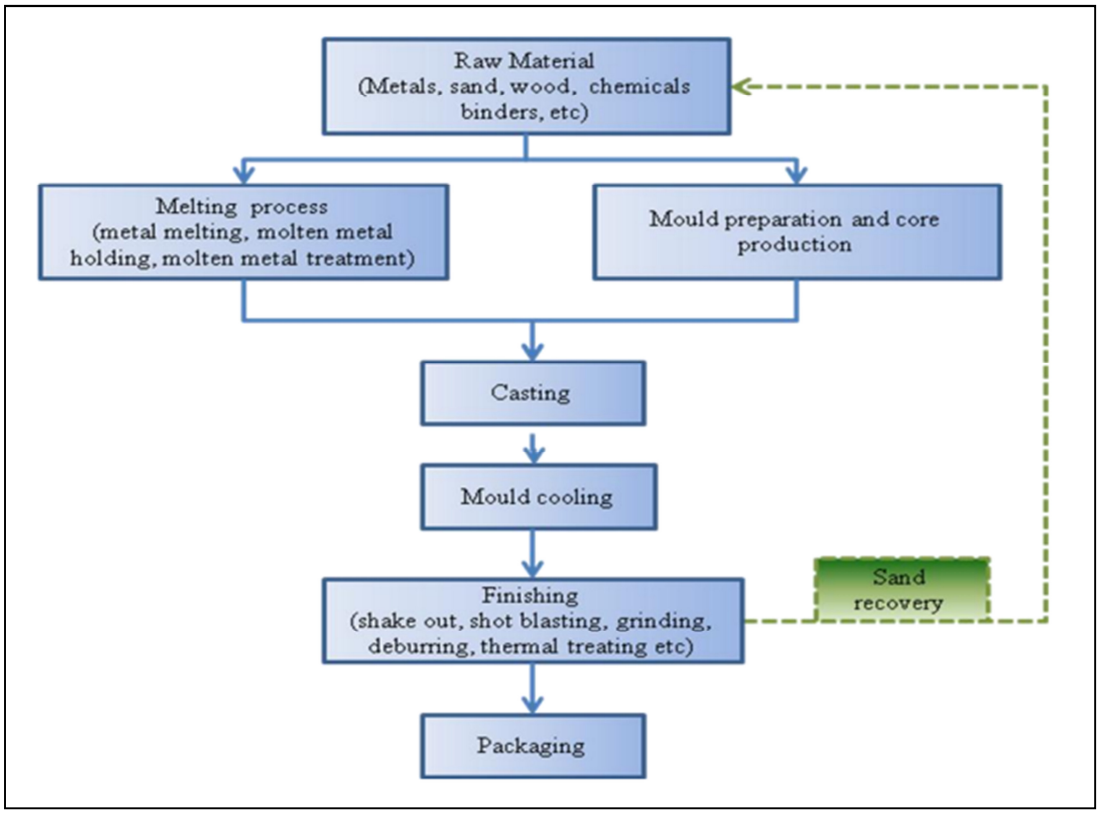

Figure 1: Process flow diagram of a Foundry Industry

Melting of metal in cupola furnaces is the most energy intensive operation in a foundry unit. The table below provides an estimate of the distribution of energy consumption in the foundry process.

STUDY AREA

ABOUT THE STUDY AREA

Belgaum city (15° 5.1 58 N and 74°3.1 27 E) is situated nearly 762 meters above the mean sea level (MSL) & is the head quarters of Belgaum district which borders the state of Goa & Maharashtra. Belgaum (earlier known as"Venugrama" or the "Bamboo Village") is one of the oldest, strong, prominent and well cultured historical place nestling near the Western Ghats. The old town area with cotton and silk weavers stands gloriously besides the modern, bustling, tree-lined British Cantonment. Belgaum has always been at the forefront of industrial growth in India. Belgaum is known for its foundry, automobile and hydraulic industry. Belgaum is one of the foundry clusters among the six of such in India. Belgaum city also has a military base, Maratha Light Infantry Regiment Centre (MLRIC) famous for commando training. Belgaum acts as a trade centre for food grains, vegetables, sugarcane, cotton, tobacco, oilseed, and milk products. The population of Belgaum city is 4.88 lakhs as per 2011. The following Monitoring locations were divided in three zones

Foundry cluster Zone 1 Udyambag industrial area,

Foundry cluster Zone 2 Angol industrial area,

Foundry cluster Zone 3 Machhe industrial area.

Fig 2: Locations for monitoring for sampling in foundry cluster zones

MATERIALS AND METHODOLOGY

METHODS FOR THE POLLUTANTS

According to the Central pollution control board (CPCB) the methods prescribed for the pollutant gases and the particulate pollutants are very sensitive ones yet percentage of errors are very less. The methods prescribed for the gases SO2, NO2, NH3 and the particulate pollutants PM10 and PM2.5 are respectively:
Improved West and Gaeke method for SO2.
Modified Jacob and Hochheiser method for NO2.
Indophenol method for NH3.
Gravimetric method for PM10.
Gravimetric method for PM2.5.
The purpose is to lay down a uniform and reliable method for sampling and analysis of SO2, NO2, and NH3 in the ambient air and also to lay down a uniform and reliable method for measurement of PM10 and PM2:5 in the ambient air of three zones for foundry clusters of Belgaum city.

Duration of sampling

The Sampling is carried out from January 2014 to April 2014, for a period of four months. Six samples were collected for Sulphur dioxide (SO2), Nitrogen dioxide (NO2), Ammonia (NH3) on every sampling day with an interval of four hours each for 24 hours duration. Three samples each were collected for Particulate matter PM10 and PM2:5 on every sampling day with Ambient an interval of eight hours each for 24 hours duration.

INSTRUMENTS USED FOR SAMPLING

Respirable Dust Sampler (RDS) Envirotech APM 460 NL [11]
Fine Particulate Sampler Envirotech APM 550 [9]
Gaseous Pollutants Sampler Envirotech APM 433 [10]

RESULTS

The present study indicates the air pollution concentration of foundry clusters area of Belgaum city divided in three zones and the concentration of different air pollutants such as Sulphur dioxide (SO2), Nitrogen dioxide (NO2), Ammonia (NH3), Particulate Matter 10 (PM10) and Particulate Matter 2.5 (PM2.5) are analyzed. Monitoring locations were divided in three zones Udyambag, Angol, Machhe sampling is done for 24 hours duration. The samples are collected during the month of January February, March and April 2014 twice monthly each.

Table 1: Month of January results

MONTH OF JANUARY RESULTS			
Parameter	**concentration in (µg/m3) in zone 1**	**Concentration in (µg/m3) in zone 2**	**concentration in (µg/m3) in zone 3**
PM10	133.6000403	129.9516908	146.2038867
PM10	140.9667325	121.1045496	133.34843
PM2.5	60.62148464	61.01763319	86.93691063
PM2.5	64.46126869	62.76779131	72.7432363
NH3	7.3669	6.9431	5.517
NH3	9.67425	8.826	6.8415
SO2	9.64425	7.1496875	8.4439375
SO2	9.185	7.2749375	8.5065625
NO2	33.85813008	24.40934959	23.12982724
NO2	30.61011179	26.27942073	26.67311992

Table 2: Month of February results

MONTH OF FEBRUARY RESULTS			
parameter	**concentration in (µg/m3) in zone 1**	**concentration in (µg/m3) in zone 2**	**concentration in (µg/m3) in zone 3**
PM10	133.34843	138.8230127	131.3103865
PM10	144.1068292	125.0192139	137.6194005
PM2.5	64.46126869	59.75731109	69.25260025
PM2.5	59.32990587	61.49151773	69.98687269
NH3	9.4731	6.622	5.5326
NH3	9.861	6.581	6.5248
SO2	9.289375	7.0244375	8.621375
SO2	8.203875	6.617375	8.2978125
NO2	31.69278455	27.3620935	29.13373984
NO2	26.47627033	21.35818089	27.75579268

Table 3: Month of March results

MONTH OF MARCH RESULTS			
parameter	**concentration in (µg/m3) in zone 1**	**concentration in (µg/m3) in zone 2**	**concentration in (µg/m3) in zone 3**
PM10	131.3103865	137.1293581	141.448698
PM10	135.2657005	132.9161177	134.5223064
PM2.5	63.23097509	60.87907877	75.59300208
PM2.5	64.46126869	59.75731109	69.25260025
NH3	10.79	7.931	7.2712
NH3	9.4731	7.989	5.8211
SO2	8.287375	6.513	9.331125
SO2	7.6715625	6.9305	9.4041875
NO2	30.3148374	21.0629065	22.93297764
NO2	31.69278455	21.2597561	29.13373984

Table 4: Month of April results

MONTH OF APRIL RESULTS			
parameter	**concentration in (µg/m3) in zone 1**	**concentration in (µg/m3) in zone 2**	**concentration in (µg/m3) in zone 3**
PM10	136.0493522	126.7018006	131.3103865
PM10	141.2082784	128.1126482	132.5030193
PM2.5	64.48685784	61.49151773	69.98687269
PM2.5	63.23097509	60.87907877	75.59300208
NH3	9.8611	7.24	6.51
NH3	10.5944	10.91	7.397
SO2	8.2351875	7.22275	9.0701875
SO2	8.72575	6.847	9.4041875
NO2	26.77154472	19.88180894	27.75579268
NO2	30.3148374	21.0629065	22.93297764

GRAPHS

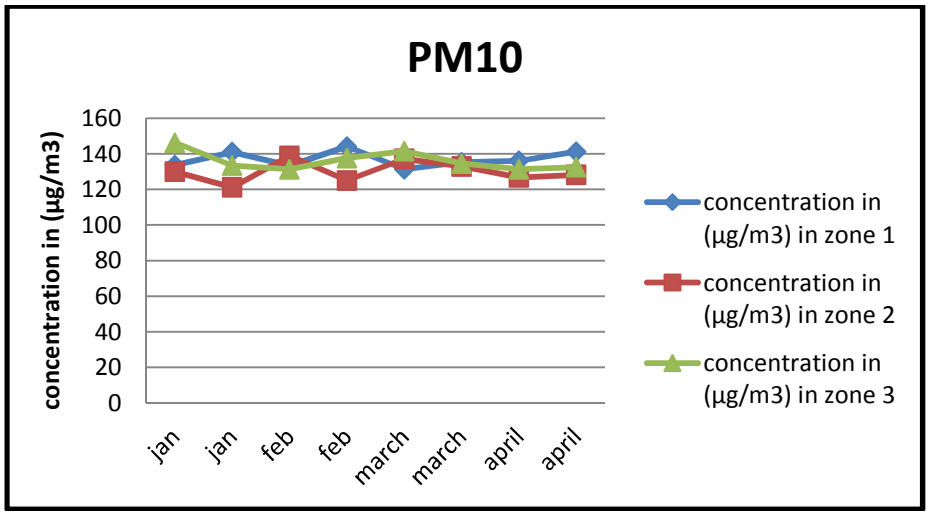

Fig 3: Concentration of PM10 for each zone

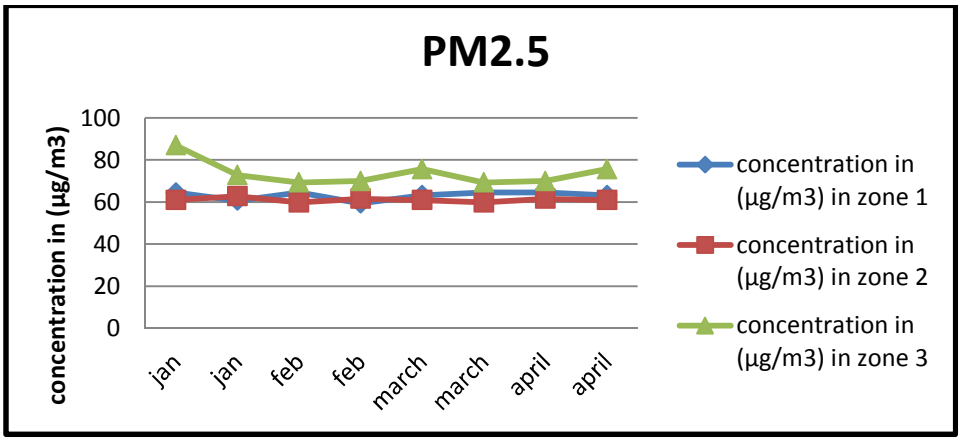

Fig 4: Concentration of PM2.5 for each zone

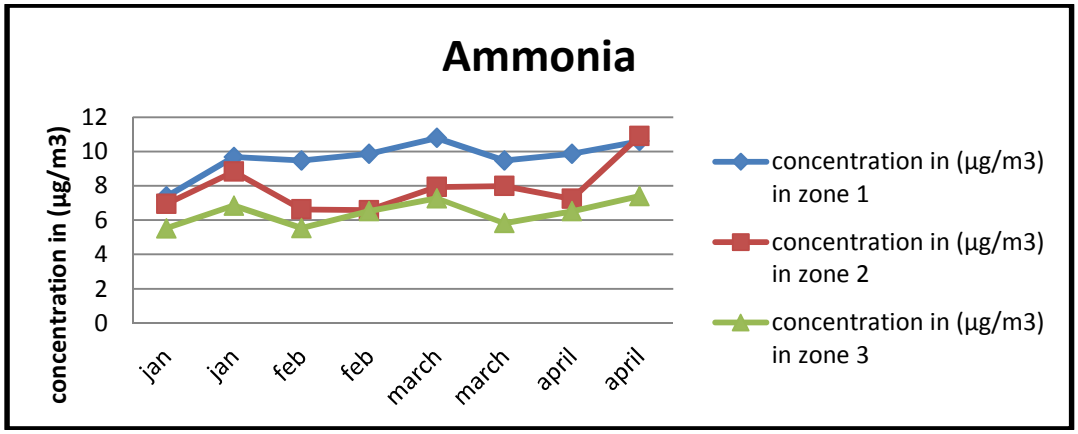

Fig 5: Concentration of Ammonia for each zone

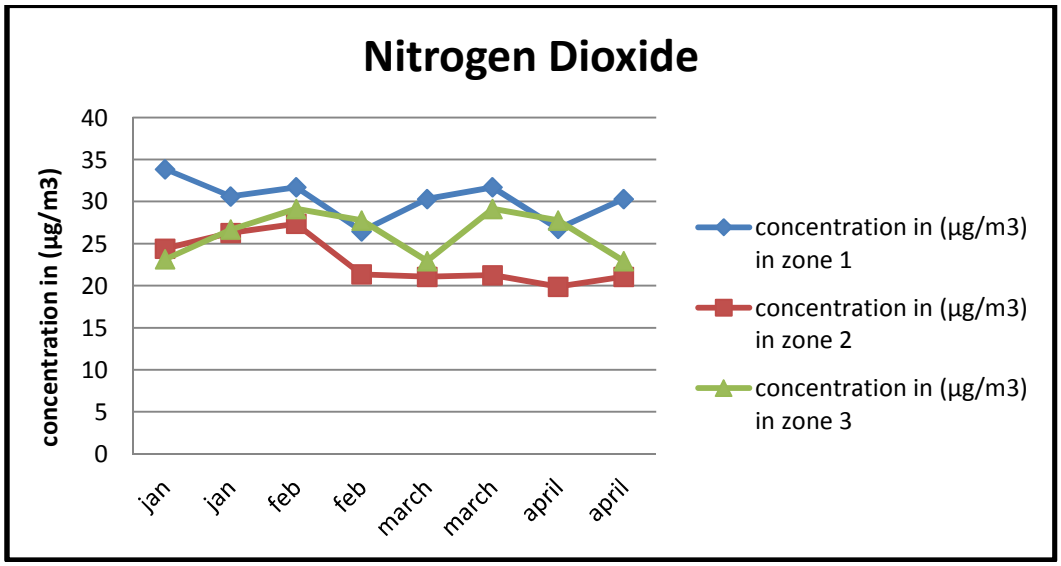

Fig 6: Concentration of Nitrogen dioxide for each zone

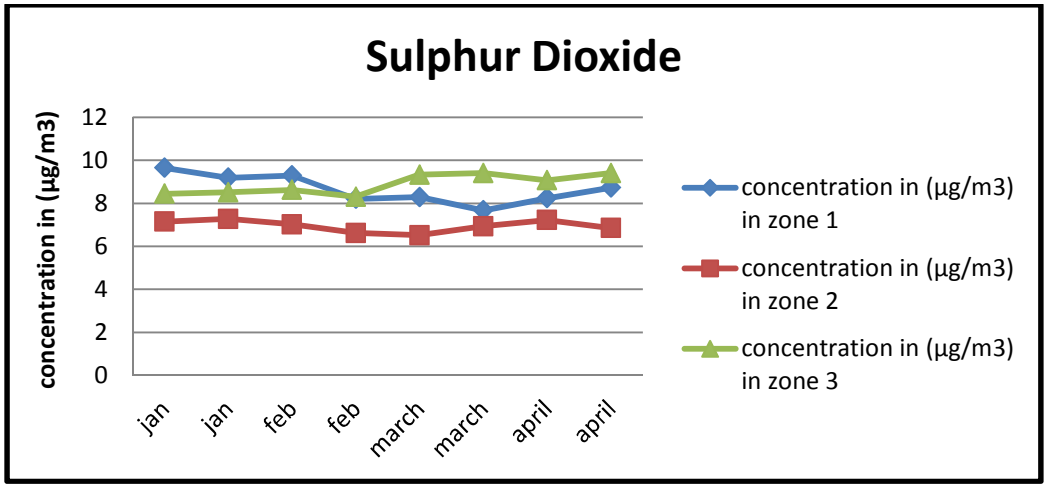

Fig 7: Concentration of Sulphur di oxide for each zone

Note: (fig 3-7) Readings were taken twice monthly in all three zones in the month of January, February, March & April for five parameters i.e. PM10, PM2.5, Ammonia, Nitrogen dioxide & Sulphur dioxide.

CONCLUSIONS

- The monitoring of Sulphur dioxide, Nitrogen dioxide, Ammonia, Ozone, Particulate Matter 10 and Particulate Matter 2.5 in the ambient air of Belgaum foundry cluster area is carried out for a period of four

months January to April 2014 at three zones of foundry cluster and sampling is done for 24 hours duration. Total three monitoring locations were selected in Udyambag, Angol and Machhe industrial area.

- The concentration of PM10 varies in the range of 121.105 to 146.204 µg/m3 which exceeds the NAAQS prescribed value of 100 µg/m3. The concentration of PM2.5 varies in the range of 59.33 to 86.937 µg/m3 which exceeded the NAAQS prescribed value of 60 µg/m3. This is mainly due to combustion of fossil fuels, lot of industrial activity and heavy traffic flow.
- The concentration of gaseous pollutant SO2 varies in the range of 6.513 to 9.644 µg/m3 which are below the NAAQS prescribed value of 80 µg/m3. The concentration of NO2 varies in the range of 19.882 to 33.858 µg/m3 which are below the NAAQS prescribed value of 80µg/m3.
- The concentration of NH3 varies in the range of 5.517 to 10.790 µg/m3 which are far below the permissible value of NAAQS of 400µg/m3.
- The present study clearly indicates that particulate matter is the major air pollutant in the ambient air in all the three zones, PM10 and PM2.5 pollutants exceed the permissible standards100 µg/m3, 60 µg/m3 respectively, but gaseous pollutants SO2 (80 µg/m3), NO2(80 µg/m3) , and NH3(400 µg/m3) were within the permissible standards as per NAAQS.
- The presence of high concentration particulate pollutants has a significant negative impact on the ambient air of study area.

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