STUDIES ON POLLUTION CONTROL IN IRON BASED PLANTS IN JHARKHAND CLUSTERS OF INDIA

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Abstract- Iron based industries in India uses the conventional blast furnace route which need coking coal, which is depleting very rapidly and India has also very limited reserves. Therefore, technology was evolved using non coking coal in which non- coking coal is used and steel is produced through directly reduced iron technology- the DRI or the sponge iron processes. The production of sponge iron has reduced the need of the polluting coke ovens and sinter plants of the conventional blast furnace route of the integrated iron and steel plants, however in direct reduction process pollution and generation of wastes is also causing pollution problem in industrial belts. Industrialization is essential to meet up upcoming demands of the evolution. All the industrial activity releases some amount of by-products as pollution into the environment. Iron and steel industry is one of the major heavy industries of Jharkhand and considered as resource intensive and pollution prone and added pollution to air, water resources, precious land. In central India many of the integrated iron and steel industry is highly polluting, non-compliant and resource-inefficient. The aim of the present review is to understand and get aware with the pollution, mainly (i) stack emission as air pollution, and (ii) check on the various processes from where fugitive emission occur in these Iron plants in Jharkhand.

Keywords- Sponge Iron, Direct Reduction, Emissions, Fugitive emission, Wastes, Induction furnace,Hot Rolling Mill, Cold Rolling Mill. Fume Extraction system, Blast Furnace

INTRODUCTION

India is the world's largest producer of sponge iron, accounting for 13 per cent of the global production8. Sponge iron is produced using either coal or natural gas. Other Iron based plants are Rerolling Mills, Pig Iron Plants, M.S Billets Plants, M.S Ingot Plants, But the largely it is covered by Sponge Iron plants.

Since non coking coal is available in India, the sector largely depends on coal based sponge iron which contributes about 80 per cent of the total capacity in the country. Today, India has an installed capacity of 36.7 MTPA of sponge iron. Leading states in sponge iron production are Odisha, Chhattisgarh, West Bengal and Jharkhand. Jharkahnd in some of the areas facing the problem of air pollution similar to other states where sponge iron plants are located. The water quality of water bodies has been severely affected which remain covered by a tarry layer over the surface of water. Groundwater table

has gone down and now water is not available even at 70-100 feet. These Iron based plants cause Air pollution. Mainly dust and gaseous pollutants (SO2 and NOX) are generated from these plants. Dust is the main culprit. It is emitted in ambient air from fixed (stacks) or diffused (fugitive emissions) sources.

In sponge Iron Plants the kiln, Coal and Iron ore crusher section, cooler discharge and product house are the major source sources of emissions. Fugitive dust emissions also occur during raw material and product handling, loading and unloading, storage, transportation of raw material and product, handling and disposal of char. Poor housekeeping is also causing air pollution in side the Plant.

Following are the major steps to control air pollution :

(1) Control system such as installation of ESP, Bag filters to achieve the prescribed emission standards.
(2) Solid waste management by reusing and recycling.
(3) Earmarking Solid waste disposal site within the plant premises.
(4) The storage site of solid waste to be scientifically designed so that the storage of solid waste does not have any adverse impact on the air quality or water regime in nearby areas.

Rolling Mills

The Rolling Mills are set up for the manufacturing of rolled products for automobile and engineering sector. Considering the fact that Alloy & Stainless Steel blooms require quick heating (to avoid decarburisation) and thorough soaking to achieve trouble free rolling, a Top & Bottom Fired Walking Beam Type Reheating Furnace has been set up in the Rolling Mill. There are two types of rolling mills- Hot and Cold rolling mills.

Hot rolling mills Operations include: • surface treatment of feedstock cast material, including scarfing, grinding and cutting to size • re-heating • de-scaling • the rolling track for hot rolled strip, including edging, roughing and strip rolling • plate production • rolling rod and bar • tube and pipe mills, including extruded tube, welded tubes and pipe.

Air pollution-Potential emissions to air arise from reheat furnaces (products of combustion), scarfing and other flame cutting activities (products of combustion and oxide fume) and pickling.

In Hot rolling mills air pollution can be minimised by: • minimising the need for surface rectification by effective quality assurance and liaison with suppliers or supply departments • enclosure of scarfing or grinding operations with extraction to appropriate gas cleaning plant. For hand grinding enclosure is not usually necessary.

Emissions of NOx can be minimised by: • use of low NOx burners • selective non catalytic reduction (SNCR) • external flue gas recirculation • selective catalytic reduction (SCR). Automated burner control and oxy fuel burners may also offer reductions in NOx emissions.

Cold rolling Mills-

On an integrated site where hot and cold rolling are carried out sequentially on the same material, the cold rolling may be considered to be “directly associated” and “having a technical connection”. A typical layout will comprise: • a pickling line, where the oxide layer formed during hot rolling is removed by acid pickling • a cold rolling mill, where the steel is rolled to reduce its thickness, typically by 50% to 80% • annealing furnaces to restore the ductility lost during cold rolling • temper mills to reharden the product to the customer’s requirements.

Operations include: • pickling • cold rolling • annealing • temper rolling of cold rolled strip.

Potential sources of emissions to air are: • acid vapours from pickling tanks • products of combustion from annealing furnaces • oil mists from rolling activities.

Air pollution in Cold Rolling Mills can be minimised by: • effective collection and treatment of acidic vapours released during pickling • minimising fuel consumption, and therefore emissions to air from annealing furnaces, by using: − automated burner controls − programmed heating cycles for batch annealing − recuperative or regenerative burners to recover heat from exhaust gases • employing low NOx burners • collecting and treating oil mists generated during rolling, if significant.

II THEORETICAL CONSIDERATIONS

According to Chatterjee (1992), inside the rotary kiln, the DRI gases flow counter-current to the kiln feed. International Journal of Mechanical And Production Engineering, ISSN: 2320-2092, Volume- 3, Issue-4, April-2015 Studies on Pollution Control in Sponge Iron Plants in West Bengal Clusters of India 39 The temperature at the product discharge end in a rotary kiln is about 950-1050°C compared to 750- 900°C towards the feed end. The counter- current flow of hot DRI gases enables it to remove the moisture content from feed. The hot DRI gases contains huge amount of fine dust comprising oxides and unburnt carbon and toxic carbon monoxide. It needs treatment before discharging into the atmosphere. In some of the bigger size plants, the heat content of hot gases is utilized to generate steam through Waste Heat Recovery Boilers (WHRB). The steam is used to operate small size turbines to produce electricity. The exhaust gases coming out of WHRB, having temperature around 150-175oC is taken to pollution control equipment for particle separation. Different industries using different type of pollution control equipment like Bag filter, scrubber and some also have Electrostatic Precipitators (ESP). The clean gas is let out through stacks. The old rotary kiln DRI plants have used Gas Cleaning Plant (GCP) based on Venturi Scrubbers (wet cleaning) for the treatment of DRI gases. This system generates dust bearing sludge that needs separate handling and disposal. However, this system can take care of particulate matter as well as gaseous pollutants. No new plants are using GCP. According to Chakravorty (2006), the SPM content of treated DRI gases of rotary kiln have been reported by some of these industries to State Pollution Control Board (SPCB) as to be less than 150 mg/Nm3 in all the plants, irrespective of the pollution control devices applied. However, there appears a gap between the reported ones and recently analysed ones. Table 1. Stack monitoring as reported to State Pollution Control Board.

In Rolling Mills Emissions to air are likely to include: • products of combustion (NOx, SOx, COx) in exhausts from reheat and annealing furnaces, process liquor heating plant and boiler plant • fine particulate and metallurgical fume in exhausts from scarfing machines • coarser particulate in exhausts from grinding and descaling activities • sulphuric acid mist from pickle tanks where sulphuric acid is in use • hydrogen chloride from pickle tanks where hydrochloric acid is in use • NOx and hydrogen fluoride from pickling plant employing mixed nitric and hydrofluoric acid systems • acid gases from acid reclamation activities • oil mist from rolling mills • fine dust and oxide fume from rolling mills • ammonia where SCR or SNCR is used.

III CODE OF PRACTICE FOR POLLUTION PREVENTION

Suitable Air Pollution Control System should be installed to achieve the prescribed stack emission standards. The following air pollution control system or combination of system are most commonly

used in such type of industry: Electrostatic Precipitator (ESP),Bag Filter, Wet Scrubber and Cyclone. The safety cap of emergency stack of rotary kiln type plant, which is generally installed above the After Burner Chamber (ABC) of feed end column, should not be used for discharging untreated emission, bypassing the air pollution control device. All de-dusting units should be connected to a stack having a minimum stack height of 30 m. However, in specific cases stack height can be reduced as specified in the notified standards. The measurement may be done, preferably on 8- hour basis with high volume sampler. However, depending upon the prevalent conditions at the site, the period of measurement can be reduced. Char should be mixed with coal or coal washery rejects and used as fuel for generation of power. It is techno-economically viable option for plants having capacity 200 TPD and above. Also the smaller capacity individual sponge iron plants (capacity up to 100 TPD) and operating in cluster can collectively install common unit for power generation. Char can be sold to local entrepreneurs for making coal briquettes. It can also be mixed with coal fines, converted to briquettes and used in brick kilns. The industry can explore other recycling techniques for char. Similarly, the kiln accretions are solid lumps and can be used as sub- base material for road construction or landfill, after ascertaining the composition for its suitability and ensuring that it should not have any adverse environmental impact. The industry can explore other recycling techniques for kiln accretions. Sponge iron plants of capacity more than 100 TPD kilns may use Waste Heat Recovery Boiler (WHRB) for generation of power. Installation of Waste Heat Recovery Boiler (WHRB) may qualify the industry for CDM benefits. Siting of new sponge iron plants s h ou l d be as per respective State Pollution Control Boa r d guidelines. In residential habitation (residential localities or village) and ecologically or otherwise sensitive areas, a minimum distance of at least 1000 m (1.0 km) has to be maintained. If any plant or clusters of plants are located within 1 km from any residential area or village they may be shifted by State Pollution Control Board.

IV. PRESENT METHODOLOGY AND ANALYSES Intensive visits to the local sponge iron plants and large numbers of data were collected pertaining to the air quality and particulate matter (suspended solids) are studied. In this paper, the abridged data of only two plants have been given in tables 2 and 3 to make it concise:

Table 2.

Data of Aloke steel Pvt. Ltd, Ramgarh,Jharkjand.

Stack Analysis

Stack	
1.Shape pf stack	Circular
2. Material made of	MS Steel
3.Stack Height	30 Meters
4.Height of sampling port	12 Meters
5.Flue used	Coal
6. Fuel consumption	2.6 ton/hr.
7.Pollution control device	ESP
8. Flue gas temperature	88 ^{o} C
9. Barometric pressure	758 mm of Hg

10.Velocity of Gas flow	4.34 m/s
11. Quantity of Gas flow	28999.04 Nm3 /hr
Coal consumption	2.4 ton/hr
Iron ore	2.5 ton/hr
Particulate matter	25.6 mg/Nm3
SO2	74.47 mg/Nm3
CO	< 0.2 %
CO2	8.6 %

Data of BIHAR FOUNDRY & CASTINGS LTD. UNIT: H.A. SPONGE & POWER,Ramga**rh**

Stack Analysis

Stack	
1.Shape pf stack	Circular
2. Material made of	MS Steel
3.Stack Height	35Meters
4.Height of sampling port	14 Meters
5.Flue used	Coal
6. Fuel consumption	3.6 ton/hr.
7.Pollution control device	ESP
8. Flue gas temperature	81 ^{o} C
9. Barometric pressure	758 mm of Hg
10.Velocity of Gas flow	5.34 m/s
11. Quantity of Gas flow	29987.02 Nm3 /hr
Coal consumption	4.4 ton/hr
Iron ore	4.5 ton/hr
Particulate matter	36.6 mg/Nm3
SO2	212 mg/Nm3
CO	< 0.2 %
CO2	9.9 %
O2	9.8 %

Cluster Small Medium Large Capacity (MTPA) - At present, no structured environmental monitoring program is followed by most of the DRI p l a n t s . Especially smaller plant like 50 tpd or 100 tpd plants are not carrying out any regular environmental monitoring at present.The DRI plants should conduct routine manual environmental monitoring of stack emissions (main kiln stack and other stacks) for temperature, velocity, PM (particulate matter), SO2, NOx, and CO. This should be carried out once in a month. Monitoring of ambient air quality using Respirable dust sampler(RDS)at plant boundary for fugitive emissions for SPM (suspended particulate matter), RSPM (respirable suspended particulate matter), SO2 and NO2 should be carried out twice in a month with solid wastes quantity and utilization potential (char, accretions, flue dust and sludge). So that the data of real time continuous monitoring system can be compared and accordingly calibration and corrective measures can be taken in CEMS.

Some of the observation

1. Some of the Sponge Iron plants dispose the solid waste including fly ash and bottom ash on agricultural land and is not kept within the plant premises. Generally Solid wastes are kept

uncovered. Different types of solid wastes generated are not stored separately which is mandatory as per the guidelines of CPCB to avoid adverse effect on air quality and water region. 2. Generally no arrangement has been made in sponge Iron plant so that operation of the plant can start in such a way that all pollution control devices shall start before start of conveyor belt/plant operation and to put off all pollution control devices only after stopping the operation of the plant. 3. They are also not complying fugitive emission standards of 2000 microgram/m3 at a distance of 10 metre from raw material crusher and product handling areas etc. 4 They also do not operate air pollution control devices such as ESP & Bag filters regularly. 5 . To curb localised dust pollution inside premises fixed type water sprinkler are installed at all dusty places inside the plant but due to negkigency and lack of maintenance they get chocked and water is not sprinkled and heavy dust pollution can be seen inside premises. 6. All sponge Iron plants should operate and maintain Closed Circuit Television (CCTV) camera rather than keeping small openings in shed for frequent observations and sheds should be provided for plant process machineries/ APCD's. 7. They should adopt the system of the telescopic chute/any other system to reduce the fugitive emission while loading the products into trucks/fine dust in the bags. 8. They should operate and maintain online stack emission monitoring system for particulate matter with connectivity to Jharkhand State Pollution Control Board server and unit shall ensure the data transfer to SPCB and CPCB server but it is obcerverd that connectivity is given but a fiexed type of data with value within the prescribed limit is transmitted however the actual value remains much more. 9. Sponge Iron Plants should provide separate electricity meter and time totaliser for continuous recording of power consumption with all APCD. A logbook should also be kept for recording daily meter reading of electricity meter connected to all APCDs. The amperage of the ID fan should also be recorded continuously. 10 There is arrangement of software controlled interlocking facility keeping in view of on-line emission and effluent monitoring system to stop feed conveyor, so that the feed to the kiln would stop automatically, if emergency/safety cap of the rotary kiln is opened or ESP is non - operational. 11. There is no water sprinkling arrangement in areas around crushing and screening units, raw material heaps at unloading points, heavy vehicle movement areas, roads and waste dump sites etc. 12. They also do not comply the provisions mentioned in MoEF and its guideline/code of practice for pollution prevention for Sponge Iron Plants. 13. the approach road and roads within premises of the plant and work areas is not asphalted or concreted. 14. The conveyor belt for transporting the materials fully are not fully covered all along its way and transfer points of conveyor belt are also not covered and suction system is not connected to de-dusting equipment. 20. The Plantation is also inadequate all along the roads and boundary wall of the industry.

Emission	Benchmark Level	Techniques which may be considered to be BAT	Comment
Oxides of nitrogen	400mg/m3 350mg/m3 250mg/m3	Low NOx burners SCR SNCR	BREF ref A 4.1.3.7 Bref A 4.1.3.8 BREF ref A 4.1.3.9
Oxides of sulphur	100mg/m3	Use natural gas as fuel	
	400mg/m3	Other gases including cleaned blast furnace gas	Control emissions of sulphur dioxide by removing sulphur from fuel gases and restricting oils to
	1700mg/m3	Use oils with less than 1% sulphur	

Emissions from scarfing, rolling, coiling, welding, shot blasting and finishing

Emission	Benchmark Level	Techniques which may be considered to be BAT	Comment
Particulate matter including metallurgical fume	10mg/m3	Fabric filter	BREF ref A 4.1.2.1
	50mg/m3	Use natural gas as fuel	
	400mg/m3	Wet electrostatic precipitators where emission is too wet to use fabric filters	BREF ref A 4.2.3.9
Oil mists	15mg/m3	Mist eliminators	

It is noted that fume extraction system should be installed for extraction of fumes and dust from all material handing points. All the de-dusting units are to be connected to stack of height 30m. Other air pollution control device which must be installed are Electrostatic precipitator (ESP), bag filters, dust collectors. Particulate emission is to be kept with in 50 mg/ Nm^3. Pulse jet bag filters is to be provided to steel melting shop (SMS). ESP has to be be provided to captive power plant and Sponge iron plant. Bag filters are must in coal crushing and coal handling area of FBC based power plant as well as raw material handling area.

Here, effort has been made in this paper in finding out the basic cause of the environmental issues, particularly with regard to the air pollution and solid waste problems, and data obtained from some local plants have been studied to evaluate the conditions existing wherein it was observed that emissions exceed the stipulated

values in majority of the cases. Related factors were analysed and some solutions pertaining to these were also proposed. Air pollution was given emphasis and water and other forms of pollution were kept out of the present scope of studies.

Closed circuit recycling system are recommended in the proposed plant. The waste water generated from the power plant should be used for ash quenching, sprinkling in the coal yard and dust suppression. Treated wastewater from SMS, CCM should be recycled for washings and dust suppression etc.

CONCLUSIOS

As stack SO2 is found quite high in some cases, the units must comply with revised stack standard, fugitive emission standard and stack height as per the CPCB norms. Most industries use DSC and Bag Filters as pollution control devices. Particulate matter in stack is usually found to be high, particularly where the scale is bigger. Hence, ESP should be used. Some industries dump the waste in open spaces in huge quantities which must be checked. Captive power plant should be proposed for utilizing coal char as well as waste heat. More emphasis on plantation should be given in order to nullify the harmful effects of emissions.Future work should be attempted to quantify the variables and establish correlations by regression or other methods.

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