STUDIES ON POLLUTION CONTROL IN SPONGE IRON PLANTS IN WEST BENGAL CLUSTERS OF INDIA

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Abstract- Production of steel through the conventional blast furnace route requires coking coal, which is getting depleted the world over and India has very limited reserves. Hence, evolution of a technology for the reduction of iron ore using abundantly available non coking coal was contemplated, giving birth to directly reduced iron technology- the DR I or the sponge iron processes. Though the sponge iron process eliminated the need of the polluting coke ovens and sinter plants of the conventional blast furnace route of the integrated iron and steel plants, in direct reduction itself, pollution and generation of wastes have been causing concern in industrial belts. In this paper, an attempt has been made to highlight the basic principles involved in 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.

Keywords- Sponge Iron, Emissions, Wastes.

I. 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. 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 iron6. Leading states in sponge iron production are Odisha, Chhattisgarh, West Bengal and Jharkhand.

Fate of West Bengal is similar to other states where sponge iron plants are located. The water quality of village onds has been severely affected having a tarry layer over the surface of water bodies. Groundwater table has been lowered and villagers claim that earlier the tube-wells only needed to be 30- 40 feet deep but now they are unable to find ater even at 70-100 feet.

Air pollution is one of the biggest hazards of these plants. Air pollutants include dust and gaseous pollutants (SO2 and NOX). Dust is a bone of contention for the sector. It enters the ambient air from fixed (stacks) or diffused (fugitive emissions) sources. The kiln, cooler discharge and product house are the potential point sources of emissions. Fugitive dust emissions are also a concern. These are produced during raw material and product handling, loading, unloading, storage, transportation of raw material and product, handling and disposal of char and poor housekeeping.

With all pollution control measures the impacts due to the plant cannot be avoided. Suitable air pollution control system shall be installed to achieve the prescribed stack emission standards. Solid waste management program should be prepared with thrust on reuse and recycling. Solid waste disposal site should be earmarked within the plant premises. The storage site of solid waste should scientifically designed keeping in view that the storage of solid waste should not have any adverse impact on the air quality or water regime in any

Analysis based on data received from WBPCB under the Right to Information Act:
Cluster Small Medium Large Capacity (MTPA): Barjora 1 3 1 0.4290, Durgapur 1 7 0.6765, JIE 6 3 0.3795 and Raniganj 1 6 0.4785

At present, no structured environmental monitoring program is followed by most of the DRI plants. Especially smaller plant like 50 tpd or 100 tpd plants are not carrying out any regular environmental monitoring at present except a few exceptions. The DRI plants should conduct routine environmental monitoring of stack emissions (main kiln stack and other stacks) for temperature, velocity, PM (particulate matter), SO_2, NO_x, and CO. This should be carried out once in a month. Monitoring of ambient air quality at plant boundary for fugitive emissions for SPM (suspended particulate matter), RSPM (respirable suspended particulate matter), SO_2 and NO_2 should be carried out twice in a month with solid wastes quantity and utilization potential (char, accretions, flue dust and sludge). STUDIES

II. THEORETICAL CONSIDERATIONS

According to Chatterjee (1992), inside the rotary kiln, the DRI gases flow counter-current to the kiln feed.

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 150-175^{o}C 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/Nm^3 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.

Stack monitoring for various capacities of the Sponge Iron plants	Values of Particulate matter (mg/nm^3) with Pollution control system are installed			
	Kiln	Cooler discharge	Coal Crusher	Product House
Stack monitoring	99-534	499		292
Stack monitoring	84-474	375	96	
Stack monitoring	47-1067	548-960	1173	110-1845

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 should be as per respective State Pollution Control Board 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 WBPCB were made and large numbers of data were collected pertaining to the air quality and particulate matter (suspended solids) and 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 Ma Chandi Durga Ispat Pvt. Ltd, Kanjilal Avenue, Durgapur.

Stack	Analysis
Shape of the stack	Circular
Material of construction	Steel
Height	30 m
Height of sampling port	12 m
Fuel used	Coal
Working fuel consumption	2.4 ton/hr
Pollution control source	ESP
Physical	Data
Flue gas temperature	82^{o}C
Barometric pressure	758 mm of Hg
Velocity of gas flow	4.34 m/s
Quantity of gas flow	28999.04 Nm^3/hr
Coal consumption	2.4 ton/hr
Iron ore	2.5 ton/hr
Result	
Particulate matter	8.3 mg/Nm^3
SO_2	79.47 mg/Nm^3
NO_x	-
CO	<0.2 %
CO_2	8.6 %

Table 3. Data of Haldia Steels Unit-2 Angadpur, Durgapur-15.

Stack	Analysis	
Shape of the stack	Circular	
Material of construction	Steel	
Height	40 m	
Height of sampling port	24 m	
Fuel used	Coal	
Working fuel consumption	6.0 ton/hr	
Pollution control source	ESP, GCT	
Physical Data	1	2
Barometric pressure	750	750 mm of Hg
Quantity of gas flow	38474.29	42617.32 Nm^3/hr
Coal consumption	5.0	5.0 ton/hr
Result	1	2
Particulate matter	35.21	43.00 mg/Nm^3
SO_2	313	216 mg/Nm^3
CO	<0.2 %	<0.2%
CO_2	10.0 %	9.8%
O_2	9.8%	8.6%
N_2	81.0%	81.4%
V.M	26.1	24.0

V. RESULTS AND DISCUSSION

As shown in plot of fig 2 between SO2 and kilns, it is evident that both Shyam Sel and Haldia Steel Unit II has quite high amounts of SO2 in the exit gases compared to Ma Chandi Ispat which may be attributed to first, the amount of non-coking coal used which is higher in the former cases, and second, because of the lower scale of production of the later. Further, it can be seen that last kiln of Sova Ispat also emits a much larger SO2 content compared to any of the kilns studied which fact may be attributed to the deficiency in their pollution control system.

It may further be noted that the quality of the non-coking coal also sometimes varies and becomes low but the company may be using it which may contribute to the factor. Fig 3 depicts the CO percentage for the kilns which indicate that the values are more or less same for all and hence CO combustion is taking place as per norms at least in these kilns. Fig 4 depicts the particulate matter status in all the kilns under study and is a very important one as it directly relates to the ambient air standard and health of the workers and locality as also the ecology of the area.

In this case, Haldia Steel has the highest particulate matter content which may be due to the scale of production as also the possibility of non-functioning of any of the dust catching units during the period of study. Fig 5 is a comparative depiction which confirms the importance of particulate emission. It may further be noted that the NOx is not monitored by these organizations and hence was not reported. It is also very difficult to penetrate these industries and collect data or sample as most of them do not seem to encourage such investigations.

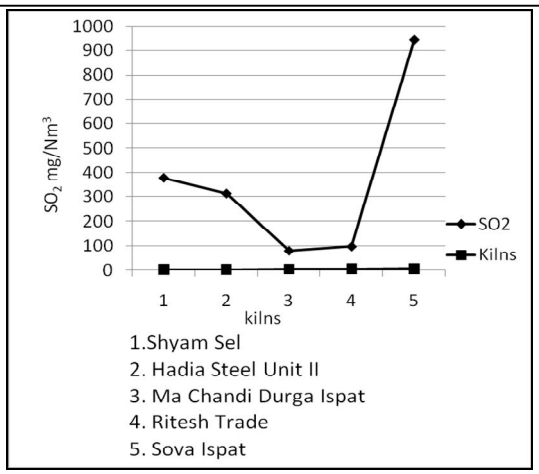


Figure 2. SO2 emissions from Kilns.

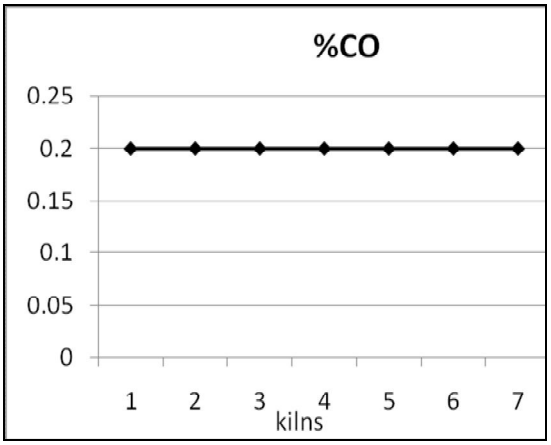


Figure 3. CO emission from Kilns.

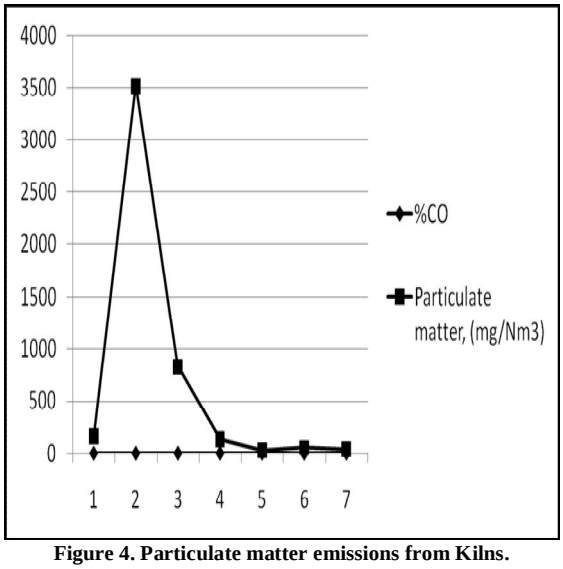


Figure 4. Particulate matter emissions from Kilns.

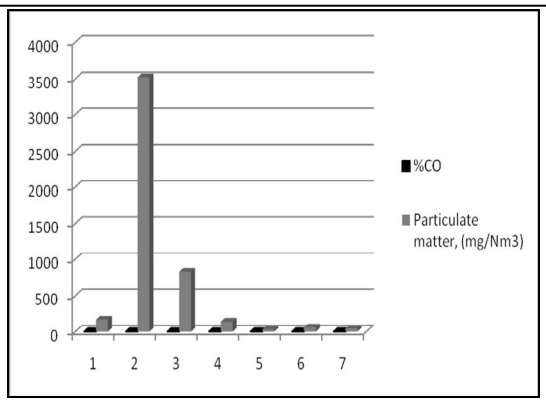


Figure 5. Particulate matter and CO comparisions

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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