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Waste management in some medium sized metallurgical industries

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ABSTRACT

In this paper, an attempt has been made to discuss some aspects of the nature of wastes generated and their management in some medium sized metallurgical industries, viz. mini steel plants of (1) M/s Special Steels Limited, Bombay; (2) M/s Sun Flag Iron and Steel Company Ltd., Bhandara Road; (3) M/s IPISTEEL, Dhenkanal; (4) M/s Incast Metal Private Limited, Bhubaneswar (Steel Casting); (5) M/s Indo Flogates Limited, Kalunga (Refractory Castings); (6) M/s Konark Malleables Private Limited, Jagatpur (Processing of Malleables) and (7) M/s Foundry Forge Plant, Ranchi (Forging). The wastes considered are solid, liquid and gaseous entities. The solid wastes are in the form of slag, mill scale, used refractory, used moulding sand, coal ash, saw dust, metal turnings and borings, various dusts from flue gases and dry grinding units, lime slurry and sludges. The liquid wastes are in the form of industrial effluents at ambient and higher temperatures. The characteristics such as pH, total suspended solids, total dissolved solids, dissolved oxygen, chemical oxygen and biological oxygen demands, oil and greases etc. are given quantitatively. The gaseous wastes consists of flue gases and fumes from furnaces and tar pots. These wastes may contain oxides of carbon, sulphur and nitrogen, cyanides, fluorides, etc. Values of these characteristics are given. Mention has been made of the requirements of the Central Pollution Control Board (CPCB) for the Iron and Steel Industry together with pollution control measures for better environmental management.

INTRODUCTION

The current contribution of Electric Arc Furnace (EAF) industry to pollution is substantial. It is estimated that the dust emitted to atmosphere is approximately 2% of the scrap charged (sometimes more depending on the quality of the scrap) with every operating EAF in the country. At the present production level (1992 data), the estimated dust let out to the atmosphere is more than 1,00,000 tonnes per year (i) which may increase several times in future.

As per the notification of Central Pollution Control Board[2-3], iron and steel industry has been categorised as one of the most polluting industries. According to

Environmental Protection, Third Amendment Rule 1990 and rules set vide schedule No.1 following parameters (Table-1) were fixed by the Pollution Board for Ferrous Industry.

Table-1 : Pollution Board's parameters for Ferrous Industries

Industry	Parameter	Standard	Remarks
Cupola	Emission	mg/Nm^3	It is essential that stack is constructed over the cupola beyond the charging door and the emissions are directed through the stack which should be at least six times the internal diameter of cupola
Capacity (Melting rate less than 3 MT/h)	Particulate matters (SPM)	450	
3 MT/h and above	-do-	150	
EAF	-do-	150	Provision is to be made for collecting the fumes before discharging the emission through the stack

Air pollution in steel melting furnaces are mainly the dust of the scrap, additives and fluxes generated during melting. Other pollutants are noxious gases such as CO_2, CO, SO_2, oxides of N_2 and metal vapours due to sublimation, paints etc.

The composition of effluents, dust and their quantum depend on several factors. The major factors include furnace capacity, transformer rating, scrap quantity and mix and carbon composition and oxygen consumption.

In the medium sized metallurgical plants, the effluents do not pose acute problem vis-a-vis other industries. The temperature and gas volume generated during each melting cycle vary as there will be fluctuations in both temperature and gas volume emission affecting the gas composition.

WASTES OF SOME INDUSTRIES

An efforts has been made to collect the data on wastes produced in some of the medium sized plant listed below:

(1) M/s Special Steels Limited., Bombay, (2) M/s Sun Flag Iron and Steel Company

Ltd., Bandara Road; (3) M/s IPISTEEL, Dhenkanal; (4) M/s Incast Metal Private Limited, Bhubaneswar (Steel Casting), (5) Indo-Flogates Ltd. Kalunga (Refractory Casting); (6) M/s Konark Malleables Private Limited, Jagatpur (Processing of Malleables) and (7) M/s Foundry Forge Plant, Ranchi (Forging).

The different types of wastes of the industries cited above, viz. solids, liquid and gaseous are dealt with individually.

Special Steels Limited, Bombay

Data on monthly generation of wastes at their Borivli Plant, Tarapur Wire Plant (TWP), Mini Steel Plant (MSP) and Wire Rod Mill (WRM) are presented in Table-2.

Table-2 : Generation of wastes

Heading	Borivil	TWP	MSP	RM
Wastes generated		per month		
1. Solids (tonne)				
a) Effluent sludge	25	9	-	-
b) Mill scale	-	-	-	150
c) Dust	-	-	30	-
d) Slag	-	-	630	-
2. Liquids (m^3)				
a) Industrial effluent	17875	10440	-	-
b) Domestic effluent	4250	-	-	-
3. Gaseous [Million (m^3)]				
a) Flue gases	11.3	4.3	-	9.61
b) Fume extraction	144.8	23.5	1.19	-

1. Solid waste:

There are three main types of solid wastes, viz. slag, used refractories and dust collected in the dust collector.

a) Slag : Approximately 4% of the steel produced slags generated in steel plant was basically compounds of lime/silica/iron oxides. There was two types having composition range and is given in Table-3.

Table-3 : Slag composition (in %)

Type	CaO	SiO_2	Iron oxides
1	40-50	18-20	10-15
2	45-55	15-20	1 - 3

b) Used refractories : Approx. 15 MT/month

c) Dust collected in the dust collector (fume extraction system)

Dust approx. 1% of the steel produced was collected from fume extraction system, analysis of dust is given in Table-4.

Table-4 : Fume Dust Analysis

SiO_2	Fe_2O_2	ZnO	CaO	MgO	Chlorides	S	P	MnO	SnO
4.7%	60.6%	24.2%	7.6%	2.4%	Tr	Tr	Tr	0.05%	-

All solid wastes are taken out of the plant in dumpers and dumped at the points authorised by Maharashtra Industrial Development Corporation (MIDC).

II Liquid Waste: Practically no liquid waste was generated in the mini steel plant. Water used for various cooling systems was re-circulated.

III. Gas wastes : Fumes generated in MSP (Mini Steel Plant) were sucked by fume extraction system and dust was removed by dust collection system. After cleaning, the gas was flowing at 14000 - 15000 m^3/h. The gas emission allowed to go out of the Chimney is given quantitatively in Table-5.

Table-5 : Gas Emission

SiO_2	25 - 30 kg/day
SPM*	15 - 18 mg/N Cu.M

**SPM - Suspended Particulate Matter*

A typical analysis of effluent samples taken during Nov. 1991 near the main pickling section is presented in Table-6.

Table-6 : Analysis of effluent samples at the outlet of effluent treatment plant near main pickling section

Sl.No.	Parameters	Observation	MPC Board Limits
1.	pH	7.2	5.5 - 9.0
2.	D.O.	5.6	not less than 5
3.	S.S.	88	not to exceed 100
4.	BOD 20°C	29	not to exceed 100
5.	COD	163	not to exceed 250
6.	Oil & grease	Nil	not to exceed 10
7.	Bioassay 90% fish after 96 hours	(Survival)	90% survival after 96 hours
Other parameters			
	Iron (Fe)	3.8	Not to exceed 5
	Zinc (Zn)	Nil	Not to exceed 3
	Lead (Pb)	Nil	Not to exceed 3

The results of such monitoring during March 1992 of the Borivil Works is given in Table-7.

Table-7 : Ambient Air Monitoring Survey Results

Location of Survey	Main pickling Plant works	Fine pickling Plant works	Boiler House
Duration of survey	8 hours	8 hours	8 hours
SPM Concn.monitored	180	169	190
SO_2 Conc. monitored	15.6	14.8	28
NO_x Conn. monitored	11.3	16.4	15.2
HCl Concn. monitored	18.2	18.2	Nil
Ambient Survey Limited :	SPM = 200 SO_2 = 80 NO_x = 80 HCl = 75		

Note: All values quoted above are in micrograms/cu.m

A typical analysis of the emission through stack of the Bead Plant at Boisar, Thane is presented inTable-8.

Table-8 : Stack analysis of Bead Wire Plant, Boisar, Thane

Sl.No.	Stack details	Sampling date	Flue Emission Details				
			Temp.	Flow cum per hr.	SPM/TPM mg/ N.cu.m	SO_2 kg/ day	Other parameter if any
1.	Boiler	25.3.92	180	1408	82	39.42	-
2.	Patenting furnace stack-1	25.3.92	206	1408	60	18.66	-
3.	Patenting furnace stack-2	25.3.92	217	1809	16	18.38	-
4.	Plant line stack	26.3.92	217	690	18	10.62	-
5.	Stress reliving stack (furnace)	26.3.92	180	700	30	11.62	-
6.	Scrubber outlet	26.3.92	30	32600	Nil	Nil	HCl=18.6 mg/cu.m Acid. Mist

SO_2 = 294 kg/day

SO_2 from stacks (actual) = 98.70 kg/day:
MPC Board Limits : SPM = 150 mg./N.Cu.M.
HCl acid mist = 35 mg/cu.m

The air monitoring survey in the premises of Mini steel Plant at Boisar conducted during April, 1992 is presented in Table-9.

Table-9 : Air monitoring survey results, April, 1992 at Mini Steel Plant Works, Tarapur Boisar

Location of survey	Furnace Chimney Premises	Admn.Office Premises	Near stores
Duration of survey	8 hours	8 hours	8 hours
S P M	149	182	164
SO_2	16.8	14.9	11.2
NO_x	18	11	14

Ambient survey limits: SPM = 200, SO_2 and NO_x = 80

Note: All concentration units and limits are in micrograms/cu.m

M/s Sun Flag Iron & Steel Company Limited (SFISCL), Bhandara Road, Maharashtra

All types of solid wastes, their qualitative and their sources are given in Table-10.

Table-10 : Solid wastes, their quantitative sources at the Sun Flag Iron & Steel Co.Ltd., in 1992

Sl.No.	Waste generated	Qty/month	Source
SOLIDS			
1.	Sludge	500 MT	Gas cleaning plant of DR Plant(DRP)
2.	Dust	1,500 MT	Gas cleaning plant of DRP & SMS
3.	Ash	2,700 MT	Gas cleaning plant of DRP
4.	Slag	1,500 MT	Electric Arc Furnace
5.	Mill scale	180 MT	Rolling Mill

Qualitative analysis of the above have not been done.

The effluents generated was 7200 m^3 and a typical analysis is given in Table-11.

Table-11 : Analysis of industrial effluent at SFISCL

Sl.No.	Waste generated	Qty/month	Qualitative analysis
1.	Industrial Effluent	7,200 m^3	pH - 8-8.5 Colour - Colourless Temperature- Ambient TSS - 43 mg/1 TDS - 1200 mg/1 DO - 5.9 mg/1 BOD - 14 mg/1 COD - 160 mg/1 Oil & grease- Nil

N.B : TSS - Total Suspended Solids, TDS - Total Dissolved Solids
DO - Dissolved Oxygen, BOD - Biochemical Oxygen Demand,
COD - Chemical Oxygen Demand

The stack gas analysis at direct reduction plant (DRP), steel melting shop (SMS) and batch melting shop (BMS) is presented in Table-12.

Table-12: Flue gas analysis of DRP, SMS and BSM

	DRP	SMS	BSM
Flue gas Temp.	190	100	198
SPM mg/m^3	150	150	90
SO_2	30	35	110
NO_x	22	14	17

M/s IPISTEEL, Dhenkanal, Orissa

The wastes generated[1] here were slags. There was no effluent. The water was recycled for cooling purpose. The other wastes generated were mill scale and end cutting used as raw material for melting furnace.

The slag was about 5-6% of the liquid metal and mainly consisted of CaO, SiO_2, MgO, MnO etc. used for land filling. In case alloy elements are higher, beneficiation and other processing may be carried out to recover molybdenum, wolframite, cobalt, vanadium etc. Analysis of a typical slag is given in Table-13 and the toxic gases in the exhaust of the electric arc furnace are listed in Table-14.

Table-13 : A typical slag analysis of IPISTEEL, Dhenkanal

Fe_2O_3	CAO	SiO_2	ZnO	PbO	MnO	MgO	Al_2O_3	Cr_2O_3	MoO_3	NiO
25-30	2-12	10-20	20-35	3-4	2-5	2-4	1-2	2-12	1-5	3-5

Table-14: Toxic gases in EAF exhaust

Harmful substances	Average Concentration mg/m^3	Amount of products exhausted (gm/ton of steel)
Oxides of Carbon	13.5 x 10^3	1350
Oxides of Nitrogen	555.0	270.0
Oxides of Sulphur	5.0	1.60
Cyanides	60.0	28.40
Fluorides	1.2	0.56

The ambient air analysis near the plant without the extraction system is given in Table-15.

Table-15: The ambient air analysis without extraction system

SPM	SO_2	N_2
280.3 mg/Nm^3	7.2	Below detection level

M/s Incast Metals Pvt. Ltd. (IMPL), Bhubaneswar

In the steel casting activity of M/s IMPL[1], about 20 tonnes of waste sand and 1 ton of other solid wastes were generated. There was no liquid waste since the system was closed cycle. The gases generated during casting was negligible since electric energy and no coal/coke was used. The wastes were used for land filling.

M/s Indo Flogates Limited (IFL), Kalunga, Orissa

Refractory slide plates, gate valves and operating mechanisms fitted with ladles in steel plants were produced[1]. Any dust produced during process were reused and hence no significant dust pollution. A Tar Plant was used in the process for tar impregnation of the plates. The tar plant consisted of pitch tank where tar was melted at 300°C and plates are put in a cage and dipped into molten tar.

The pitch tank was completely enclosed in a closed steel chamber. The fumes were extracted through a blower with ducts where condensation took place in a condensing chamber and anthracene was collected in drums which would be used again in the process. The whole arrangement was made inside factory area. Soaking pits inside the factory were provided for checking any pollution through water.

M/s Konark Malleables Pvt. Ltd (KMPL), Jagatpur, Orissa

M/s. KMPL processes malleables and wastes generated included solids, liquids and gases. The solid wastes were slags due to smelting of mild steel scraps, burnt out/ used refractories and their magnitude was 120 kg/batch. These were used for land filling in low lying land.

According to the Malaysian Standard[4], the concentration of benzene soluble tar for stationary and mobile plants are 500 mg/m^3 and 700 mg/m^3 respectively. Authors are unaware of similar Indian Standards.

M/s Foundry Forge Plant (FFP), Ranchi

The solid wastes generated were[1]:

(a) Lime slurry in the acetylene plant at the rate of 500 tpy. The slurry containing 51% solids which in turn had 88% CaO and 1.5% MgO.,

(b) Slack coal generated in coal handling for producer gas plant, a part of which was consumed in boiler house and the rest disposed by selling to outside parties. Annual generation was 10,000 tpy.

(c) Used sand generated in sand plant of foundries. A part was reused in admixture with new sand and the rest was disposed off in un-inhabited areas outside the plant. Daily generation was : 160 ton/day, with typical analysis of SiO_2 - 97%, Na_2O - 0.4%.

(d) Coal ash was produced in a manufacture of producer gas : It was disposed off in un-inhabited areas outside the plant with a typical analysis - SiO_2 - 53%, Al_2O_3 - 23%, Fe) - 7%, CaO - 1.7%, MgO - 0.8%.

(e) Slag cakes produced during steel making in electric arc furnace of steel melting shop at 4500 tpy was dumped outside the plant for filling pits.

Typical analysis was : CaO - 50%, MgO - 10%, SiO_2 - 20%, FeO - 0.6%, Al_2O_3 - 8.1%.

(f) Saw dust : A bye-product from Pattern Shop generated at 12 tpy was disposed off in low lying areas outside the plant. This could be used for energy recovery.

(g) Turnings and borings : The turnings and borings generated in machine shops were recycled in electric arc furnaces.

The effluent consisted of used process water from various manufacturing operations was discharged to Suvarnarekha river. A typical analysis is given in Table-16.

Table-16 : Process water effluent analysis

pH	-	6.4
Oil and grease	-	9.0 mg/l
Phenolic compounds	-	Less than 1 mg/l
Cyanide	-	Nil
Ammoniacal nitrogen	-	3.0 mg/l
Suspended solids	-	25 mg/l

Gaseous pollutants were generated because of carbonising of about 200 tpd of rubble coal and production of producer gas used in various shops. The flue gases were discharged through 8 number of chimneys inside the plant.

The flue gas and ambient air analysis are given in Tables-17 and 18 respectively.

Table-17 : Flue gas analysis ($\mu g/m^3$)

SO_2	CO	NO_x	HC
3	B.D.L.	0.3	B.D .L.

Table-18 : Ambient air analysis

SPM	SO_2	NO_x	CO
260	4	5	B.D.L.

B.D.L. Below Detection Limited

WASTE MANAGEMENT

Management of different wastes are given below :

Solids

1. Dumping at site specified by land authorities or within the company premises in low lying areas were/may be done.
2. Slags were/may be utilised for building roads and filling low lying areas
3. Beneficiation of slags to recover molybdenum, tungsten, cobalt, vanadium and other valuable metals were/may be used.
4. Slag were/may be used as fertilizer or for making cement.

Liquid

1. Water used for various cooling systems may be recycled. Recycling of effluent waters serves to minimise fresh water consumption and lowers pollution load to the environment.
2. Effluent may be treated before letting into sewerage systems/natural water bodies.
3. Effluents were/may be used for agri/horticultural purposes.
4. Provision may be made of soaking pits to absorb the contamination of water before letting into environment.
5. Provision may be made of soil separators to capture oil and grease from used waters before discharge to public water bodies.

Gaseous

1. Effluent and appropriate dust collection and scrubbing systems may be used

to reduce the dust load to the atmosphere and helping resource recovery from such dusts.

2. Fugitive emissions to be minimised through good house keeping procedures in the various manufacturing operations as well as in handling, conveying, transport and storage of raw and intermediate materials.

Because of small scale nature of some of the metallurgical operations such as foundries, who individually cannot operate and maintain sophisticated pollution control equipments, it is suggested that a co-operative effort on the part of such industries located nearby is called for.

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