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Draft Indian Standard

SOLID WASTE MANAGEMENT IN INTEGRATED STEEL PLANTS – CODE OF PRACTICE

(First Revision of IS 10447)

ICS 13.030.10

Solid Waste Management Sectional Committee, CHD 33

Last date of comments: 06 10 2022

FOREWORD

(Formal clauses to be added later)

An Indian integrated iron and steel plant produces approximately 1.1 tonne of solid wastes for every tonne of ingot steel produced. This figure does not include ore fines and slimes of ore crushing plant at mines, and middlings or rejects at a coal washery.

The production of such large capacity waste make a significant adverse environmental impact. Consequently, efforts are needed to minimize the waste produced through recycling, re-use, elimination of the use of toxic substances etc. Such efforts would help reduce/eliminate potentially adverse environmental impacts. It will also make steel manufacturing more environment friendly.

There is a need to develop processes for the waste generated which can be suitably utilized in the downstream industries such that the same is consumed in the related manufacturing cycles. This may also help in conserving the natural resources including energy conservation.

This standard describes guidelines for disposal and use of solid wastes generated by integrated steel plants which should be implemented in conjunction with relevant notifications of Ministry of Environment, Forest and Climate Change (MoEF&CC) Notification and Guidelines of Central Pollution Control Board (CPCB).

Wherever this standard mentions about selling Solid Waste to authorized agencies, it means that they shall be authorized by designated agencies.

This standard was originally published in 1983. Significant quantities of wastes are generated from steelmaking process which is a focus point now-a-days w.r.t. its utilization as well as environmental impact. The solid wastes generated from the process of a steel industry principally consist of slag, sludge, dust & fines, mill scales, refractory wastes. Iron (BF) slag and steel (BOF) slag contribute the major share (around 90%) of solid waste generation.

Therefore, this standard has been revised to include latest guideline regarding chemical composition and possible uses of BF and BOF slag.

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1 SCOPE

1.1 This standard describes the guidelines for disposal and use of various wastes generated by the integrated steel plants. Source of generation and characteristics of these wastes have also been prescribed.

1.2 This standard does not cover wastes generated at mines and collieries. It also does not include spillage at various stages of processing which is recycled into the system, for example, dust at coke ovens, sinter plant, etc, and also wastes generated in small quantities like dust from open hearth furnaces and sludge from water softening plants.

2 REFERENCES

The standard listed below contains provisions, which through reference in this text, constitute provisions of this Standard. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below:

IS NO.	*Title*
455 : 2015	Portland Slag Cement - Specification
3677 : 1985	Unbonded Rock and Slag Wool for Thermal Insulation
9569 : 1980	Glossary of terms relating to solid wastes
10153: 2021	Utilization of Fly Ash Guidelines
12089 : 1987	Specification for Granulated Slag for the Manufacture of Portland Slag Cement
16714 : 2018	Ground Granulated Blast Furnace Slag for Use in Cement, Mortar & Concrete-Specification
16715 : 2018	Ultrafine Ground Granulated Blast Furnace Slag- Specification

3 TERMINOLOGY

For the purpose of this standard the definitions of the terms, symbols and units given in IS 9569 and the following shall apply:

3.1 Blast Furnace Gas Cleaning Plant Sludge — These are finer particles of dust finally removed from the blast furnace gas in the gas cleaning plant.

3.2 Blast Furnace Slag — A non-metallic product consisting mainly of CaO, SiO2, Al2O3 and MgO, coming out of the iron making blast furnaces. It is originally in liquid form but is finally disposed off as a solid after cooling.

3.3 Bottom Ash — The coal used in the grate type boilers turns into clinker form after combustion is known as bottom ash.

3.4 Coal Tar Sludge — This material accumulates below the tar in the coke ovens by-product plant. It is a soft solid mass which turns into fluid at a temperature around 75-80°C.

3.5 Fines and Dust from Calcining Plant — These fines are generated during the processing of dolomite for the supply of sized material to steel melting shops. Lime and dolomite dust are also generated during calcination of lime stone and dolomite in the kilns.

3.6 Flue Dust — The gas emitted by a blast furnace is laden with dust as it comes out of the furnace. The coarser particles collected in the dust catcher during the gas cleaning process are called flue dust.

3.7 Fly Ash — Fly ash is a finely divided residue resulting from the combustion of ground or powdered coal and carried along with the flue gases of boilers fired by pulverized coal.

3.8 Foundry Wastes

a) Foundry Sand **—** A part of silica sand which is burnt is generated as a waste in the foundry.

b) Cupola and Electric Furnace Slag — A slag generated during cupola or electrical furnace melting.

3.9 Mill Scale — While steel ingots or other sections are heated in soaking pits or reheating furnaces before rolling, the outer skin of the material is oxidised. The oxidised layer, called mill scale, drops down in the furnaces or under the rolling table.

3.10 Slimes — During crushing and washing of iron ore within the steel plant for improving its quality and size, finer fraction (less than 200 µm) is carried away by water in the form of slurry into a pond. These fine particles of iron ore are called slimes.

3.11 LD Converter/Open Hearth Slag — This material is generated during conversion of iron into steel in a steel making furnace.

3.12 Wastes from Refractories — Used broken bricks are generated during breaking of the refractory lining for rebuilding various furnaces. Dusts of various refractory materials are produced during the manufacture of refractory mortars or bricks in integrated steel plants.

4 SOLID WASTES

4.1 The characteristics, quantity, and possible uses of the various solid wastes generated in an integrated steel plant are given in Table 1.

TABLE 1 GENERATION, CHEMICAL COMPOSITION AND POSSIBLE USES OF SOLID WASTES

(*Clause* 4.1)

SL NO. (1)	TYPE OF WASTE (2)	TYPICAL QUANTITIES GENERATED IN INTEGRATED STEEL PLANT OF 2 MILLION TONNE INGOT STEEL (3)	PERCENT OF TOTAL QUANTITY (4)	TYPICAL CHEMICAL ANALYSIS AND (SIZE) (5)	MODE OF UTILIZATION/ DISPOSAL (6)
i)	Iron ore slimes from ore crushing plant inside works	2 500 - 3 500 tonne/ month (4-6 percent of ore processed)	1.7	Fe = 55-60, SiO_2 = 3-6 Al_2O_3 = 4.7 (60 percent smaller than 75 µm)	As a feed to pelletizing mix (20 percent Max) for improving Al_2O_3/ SiO_2 ratio of burden and improved strength of pellets during reduction.
ii)	Blast furnace flue-dust	5 000 - 6 000 (35-45 kg/t hot metal)	3.2	Fe = 32-35, SiO_2 = 7-9, Al_2O_3, = 6-7, CaO = 6.5 – 7.5, MgO = 3-4, C = 21-24 (80-90 percent between 500 and 75 µm)	As a feed to the sinter plant. Ratio to be decided on the basis of operating condition of plant and size of flue dust.
iii)	Sludge from gas cleaning plant	3 500 - 4 500 (25-30 kg/t hot metal)	2.3	Fe = 33-35, SiO_2 = 6-8 CaO = 7.5 – 8.5, FeO = 9-10, C = 22-25 (more than 80 percent smaller than 45 µm)	Generally disposed off on land in the form of cakes.
iv)	Blast furnace (BF) slag	85 000 - 95 000 (600 kg/t hot metal)	52.2	CaO = 29 - 36, SiO_2 = 16 – 37 Al_2O_3= 17 – 35, MgO = 1 – 10 FeO/Fe_2O_3/TFe = 0.3 - 0.6 S = 0.5 - 0.8 MnO= 0.1 – 0.5	a) When molten BF slag is transformed into granules under high pressure water jet in hot condition through Slag Granulation Plant (SGP), then it is termed as Granulated BF Slag. The granulated BF slag is an amorphous, coarse sand-sized material. It is utilised in cement

					manufacturing (See IS 455,IS 12089, IS 16714, IS 16715) b)To make light weight slag for use as insulating material(IS 3677), and c) When molten BF slag gets solidified due to natural cooling, then it is termed as Air-cooled BF Slag. Air cooled BF slag can be utilised for construction of road and for slag wool manufacturing.
v)	Steel slag (BOF slag) It is a by-product of the steelmaking and steel refining processes. Different types of steel slag are generated from basic-oxygen-furnace (BOF) steelmaking, electric-arc-furnace (EAF) steelmaking, and ladle-furnace steel refining processes.	115 -165 kg per tonne		CaO = 30-52 SiO2 = 10 -19 Al2 O3= 1 - 2, MgO = 6 - 15 FeO/Fe2O3/TFe = 14 - 24 MnO= 0.6 – 1.6 P2O5 =1.2 - 2.7	BOF slag is utilized in sinter making. Maximum 30 - 35 kg of BOF slag can be recycled per ton of sinter base-mix. Presence of high phosphorous and sulphur content affect its recyclability through sinter.
vi)	Steel making slag a) Open hearth slag (30/40scrap,60/70 hot metal)	27 000 – 30 000	16.6	Flush slag: SiO2=20.1, Fe2O3 = 3.6, FeO = 30.4, Al2O3 = 5.9, CaO = 20.2, MgO = 6.1, P2O5 = 4.6, MnO = 7.0 Tap slag: SiO2=18.6, Fe2O3 = 4.0, FeO = 13.1, Al2O3 = 4.8, CaO = 37.0, MgO = 12.0,	a) High CaO/SiO2 ratio slag as a soil conditioner in agricultural fields having acidic soil. b) Partly charging to the sinter mix, and c) High P2O5 slag for manufacture of fertilisers.

				P2O5 = 3.3, MnO = 7.0	
	b) LD converter slag	120 - 220 kg/t steel		CaO = 43-50 SiO2 = 13-16, MgO = 5-8, MnO = 3-5, P2O5 = 2-3, FeO = 16-20	a) Soil conditioner for acidic soil, and b) Source of flux in the blast furnace either directly or through the sinter.
vii)	Mill scale (Both primary and finishing mills)	6 000 - 7 000 (2.5 - 3.5) 3.5 percent of input material rolled		Fe = 31.2, FeO = 63.3 SiO2 = 1.4, A2O3 = 0.4, CaO=0.2, MgO=0.9	a) As a feed in the sinter plant (— 10 mm), b) Recycle through open hearth furnace (+6 mm), c) Feed to pelletizing mix (up to 5 percent) to increase compressive strength of pellets, and d) As feed to blast furnace (+l0mm).
viii)	Fines and dust at calcining Plant a) Dolo fines (—5 mm) b) Dolo dust c) Lime dust	 1 300 – 1 400 100 – 150 400 - 450	1.1	 — — —	As a feed in sinter. a) For spreading on the ground with tar sludge for preventing growth of vegetation, and b) Adding to steel melting shops after briquetting.
ix)	Refractories a) Used broken bricks† b) Dust (chrome, magnesite, kyanite, clay, etc)† c) Dust (magnesite)	 400 - 500 200 - 250 100 - 150	0.5	 — — — 	 Crushed and used for Making mortar. Used for making mortar. Feed to sinter mix.
x)	Coal tar sludge	200 - 300		—	Mixing with lime dust and hot pitching to prevent growth of vegetation.
xi)	Bottom ash	24 000	13.9	SiO2 = 41.9, Al2O3 = 21.3,	Bricks for building purposes and

				Fe_2O_3 = 5.7, CaO = 1.7, MgO = 0.94, (Na_2O + K_2O) = 0.32 TiO_2 = 2, P_2O_5=1 Total (SO_3 + SO_4) =0.54, Loss on ignition = 27.6	construction of walls by casting along with fly ash.(See IS 10153)
xii)	Fly ash	7 500 (If only coal is used)	4.3	SiO_2 = 50.55, Al_2O_3 = 22.25, Fe_2O_3 = 2.4, CaO =< 2.5, MgO = 0.25, Total (SO_3 + SO_4) = 2.5 (Na_2O + K_2O) = 1.0, Max,TiO_2 = 1.9, P_2O_5 = 0.9, Loss on ignition=3 percent Size : more than 106 µm = 12-20 percent, 106 to 75 µm = 15-25 percent, less than 75 µm=60-70 percent	See IS 10153
xiii)	Foundry sand	500-700	0.3	SiO_2 =80 percent, balance Fe_2O_3, TiO_2 and Al_2O_3	Half of the sand may be used for recycle after screening the fused material.
xiv)	Sinterning plant slime (recovered from battery cyclones of exhausters and other de-dusting units)	50 - 80 kg/t of sinter	—	Total Fe = 35-40, FeO = 2-4.5 SiO_2 = 6.9, Al_2O_3 = 4-5.5, CaO = 11-14, MgO = 2-4, Loss on ignition = 7-10 percent Size : 0.0 percent larger than 5mm, 0.3 percent larger than 3mm, 50-60 percent larger than 150 µm, and 40-50 percent smaller than 150 µm.	60 to 70 percent of the total slime may be used along with the sinter mix. All of it may be used in the sintering mix if the moisture is brought down to l0-15 percent.
xv)	LD converter dust	10-15 kg/t steel	—	Fe total = 65.0 (Fe metal = 24.6, FeO = 49.4 and Fe_2O_3 = 1)	May be used as a source of iron in blast furnace either through

				CaO = 5.7, SiO2 = 3.5, Al2O3 = 0.5, MgO = 0.9, MnO = 2.0, S = 0.14, P2O5 = 0.5	sinter after air classification to use + 0.125 mm (which is about 50 percent) or by briquetting with suitable binders.

NOTE — The figures given are likely to vary from plant to plant depending on the raw materials used and operating conditions. Since the possible uses of wastes are dependent on their chemical and physical properties, corresponding variations are likely in this respect also.