



Review Article

Process Waste Generation and Utilization in Steel Industry

Mukuldev Khunte

Department of Metallurgical & Materials Engineering, OP Jindal University, Raigarh, India

Email address:

rinkukhunte@gmail.com

To cite this article:

Mukuldev Khunte. Process Waste Generation and Utilization in Steel Industry. *International Journal of Industrial and Manufacturing Systems Engineering*. Vol. 3, No. 1, 2018, pp. 1-5. doi: 10.11648/j.ijimse.20180301.11

Received: April 14, 2018; Accepted: May 2, 2018; Published: May 11, 2018

Abstract: Steel production process is a complex process. For manufacturing of steel material various processes are required to do, that causes the production of the high amount of waste which need to be processed. Production of any product causes waste which has very less economy for the primary production process, but those waste products also have some economic value which can be increased by processing. In this paper, the production of waste in major industries and utilization of that waste and handling of waste has been studied. The paper mainly consists of waste production and utilization in steel industries, best possible way to get “Best from the waste”. The steel industries are one of the major waste producers, but they have invented new methods to utilize the wastes. These new methods helped for sustainable developments as they help in getting more efficiency and reducing the cost of primary methods. As per the ISO 14000 standards industries need to follow so many standards for recycling of the waste material.

Keywords: Steel Industry Waste, Hazmat, Process Waste, Waste Management, ISO 14000

1. Introduction

An important criterion of justifying strong economic growth in a nation is the degree of industrialization in it. Although rapid industrialization is a sign of development, it adversely affects the environment due to the release of large quantities of toxic [8]. Generation of the industrial waste is closely related to the industrial growth process and increase in demand. Production of any useful product always causes waste, but the thing is that “Are they really a waste” [4, 3]. Up to some extent wastes also have some economic value which needed to get extracted from it, as well as, handling of these wastes in a proper manner can provide stability in nature [5].

In recent years it has been observed that the industries are giving more negative impact [1] on the society than that of positive. To make the world sustainable management and utilization of waste become important.

2. Waste

Waste is any material which is discarded by somebody or not suitable for that process (although it may be useful for somebody else) [2, 6]. Solid waste is a big task to handle by

engineer’s planner’s groups of society. A huge amount of waste need to be utilized by different methods and ways cause its generated in the large amount as it seems by collected data around the world [7]

Industrialization, modernization, and progress all of these did take a toll on the health of our planet. When junk removal or management is improperly done, it can lead to health problems while also adversely impacting the surrounding environment. Here are some types of solid waste which need to be controlled. [21]

- Organic Waste
- Pollutants
- Agricultural and industrial waste
- Medical Waste
- Disposal Sites
- Plastics

2.1. Waste Management

India is a heavily populated country and this is the only reason for enormous wastes being produced [12]. Recycling of waste material saves natural resources, saves energy, reduces solid waste, reduces air and water pollutants and reduces greenhouse gases [14]. Waste management is a

collection, transportation, and disposal of garbage, sewage, and other waste products. It is a process of treating solid wastes and offers a variety of solutions for recycling items that don't belong to trash [22]. In other words, Waste management is all the activities and actions required to manage waste from its inception to its final disposal. This includes amongst other things, collection, transport, treatment and disposal of waste together with monitoring and regulation.

There are various types of solid waste including municipal (residential, institutional, commercial), agricultural, and special (health care, household hazardous wastes, sewage sludge).” You will find there are eight major groups of waste management methods, each of them divided into numerous categories.

Usually, if pollutants come from one source into that water body, (such as a factory disposal) it is called a point source pollution. Generally, waste could be liquid or solid waste. Both could be hazardous.

Liquid and Solid Waste types can also be grouped into organic, reusable and recyclable waste

2.2. Sustainability

There are the number of useful definitions of sustainability and the World Commission on Environment & Development has defined it as [3]:

‘Meeting the needs of the present generations without compromising the ability of future generations to meet their

own needs’

The primary objective of waste management is to completely prevent the production of waste altogether, if possible [1, 2]

Second, if waste must be produced, then it is to be recycled. Entirely avoiding waste production or recycling [16].

2.3. ISO 14000 Environment Management System

The ISO 14000 standards represent a consensus agreement by national standards bodies around the world about the procedures that need to be followed in establishing an effective environmental management system (EMS).

The ISO 14000 series include standards for

- (1) environmental management systems,
- (2) environmental auditing,
- (3) environmental performance evaluation,
- (4) environmental labels and declarations and
- (5) life cycle assessment. [1]

3. Major Waste Producers in World

From the figure 1, the united states of America and Russia are the major producer of the waste. The most common waste from these countries are clothing and footwear, Food, furniture, and furnishings. And they are also the major producers of industrial waste. [17]

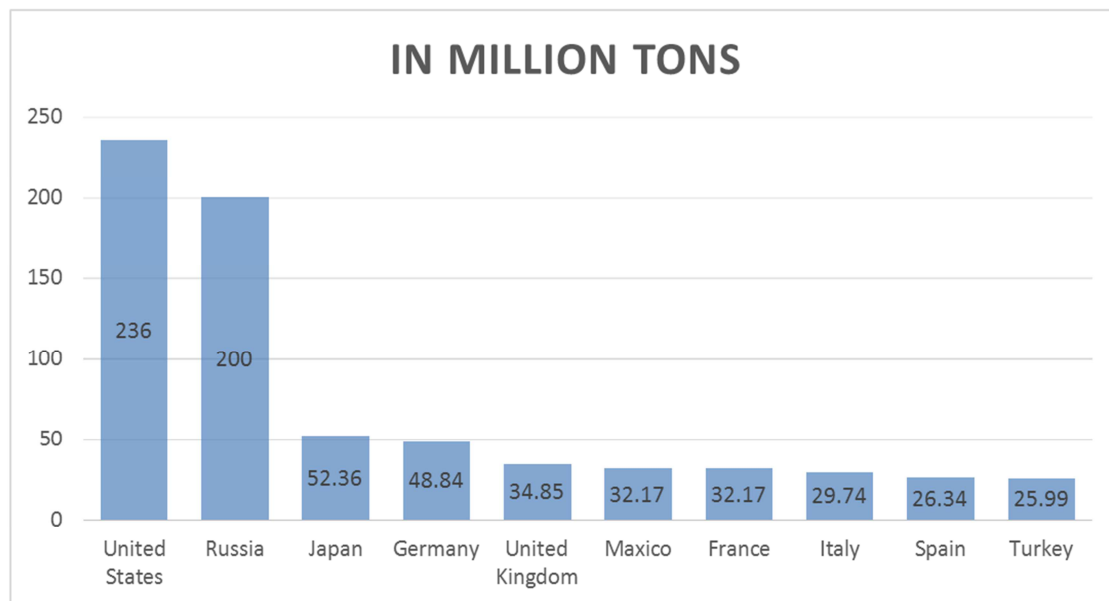


Figure 1. Major Waste Producers in World.

4. Mineral Producing Countries

India is ranked fourth among the mineral-producing countries, behind China, the United

States and Russia, based on volume of production (FICCI, 2013). The GDP contribution of the mining industry varies from 2.2% to 2.5% but going by the GDP of the total industrial sector, it contributes around 10%–11% [1].

5. Types of Waste During Various Process

This article divides the steel production process in six major processes which are done to produce steel-related materials. As indicated these are major processes therefore most of the waste is also produced during these processes.

The processes are

1. Raw Material Agglomeration

2. Blast furnace process
3. Basic oxygen furnace
4. Electric Arc Furnace
5. Steel, Stainless steel refining
6. Casting and Milling Process

5.1. Waste During Raw Material Agglomeration

Agglomeration the process in which the sticking of material with their respective other materials are done such that the material can get the desired shape [14]. It is the primary step to produce any steel material.

Table 1. Agglomeration Process Waste.

Waste	Amount	Uses / Importance
Coke oven Gas	280–450 Nm ³ /ton coke*	Coke oven gas is normally used in coke oven battery heating
Coke dust/ breeze	15.7–298 g/ton coke*	Coke Breeze is used by various industries such as refractories, sintering operations and cement industries
Sinter Bending Dust	0.5–37.7 g/ton sinter*	It contains Valuable minerals such as KCl, Fe ₂ O ₃ , CaCO ₃ , CaMg (CO ₃) ₂ , NaCl, SiO ₂
Sinter Secondary Dust	14.5–40 g/ton sinter*	Can used for Reproduction of Mineral.
Pelletization Dust	14–150 g/ton pellets*	Reusable

*From reference 1,9

5.2. Waste During Blast Furnace Process

Two different process routes are available to produce steel products, namely the blast furnace with oxygen steelmaking [9] and the electric arc steelmaking route [2]. In both the process the Blast furnace process plays an important role in production of any steel product. Thus, causes production of waste too.

Table 2. Blast Furnace Process Waste.

Waste	Amount	Uses / Importance
Blast furnace dust	7–45 kg/ton HM*	consists of iron, with some zinc and other elements oxides
Blast furnace sludge	6 kg/ton HM*	highly problematic, due to zinc content
Blast furnace slag	200–400 kg/ton HM*	for concrete aggregates, concrete sand, glass insulation wool, filter medium, and use under concrete slabs as a platform.
Refractory bricks	5.9 kg/ton HM*	could be used in the concrete production as aggregates

*From reference 1,9

5.3. Waste During Basic Oxygen Furnace

The Basic Oxygen Steelmaking (BOS) process is the dominant steelmaking technology [4]. BOF share of production in the U.S., was 33% in 2016. The primary raw materials for the BOP are 70-80% liquid hot metal from the blast furnace and the balance is steel scrap. [18]

Table 3. Basic Oxygen Process Waste.

Waste	Amount	Uses / Importance
BOF slag	85–200 kg/ton liquid steel*	Used as road ballast and land filler
Desulphurization slag	3–40 kg/ton liquid steel*	Used to improve desulphurization Rate
BOF Sludge	15–16 kg/ton liquid steel*	Rich In minerals, Good cold strength
BOF dusts	14–143 kg/ton liquid steel*	self-reducing pellets and can be used in the blast furnace process.
BOF Refractories	Not available*	Reused after processing

*From reference 1,9

5.4. Waste During Electric Arc Furnace

The electric arc furnace operates as a batch melting process producing batches of molten steel known "heats"[9,2]. The electric arc furnace operating cycle is called the tap-to-tap cycle and is made up of the following operations:

1. Furnace charging
2. Melting

3. Refining
4. De-slagging
5. Tapping
6. Furnace turn-around

Modern operations aim for a tap-to-tap time of less than 60 minutes. Some twin shell furnace operations are achieving tap-to-tap times of 35 to 40 minutes. [19]

Table 4. Electric Arc Furnace Process Waste.

Waste	Amount	Uses / Importance
EAF dust	15–20 kg/ton liquid steel*	Recycled Using sintering of a composite
EAF slag	100–180 kg/ton liquid steel*	an ideal aggregate for asphalt surface materials and road surface treatments
Refractory bricks	2–25 kg/ton liquid steel*	Reused after Processing

*From reference 1,9

5.5. Waste During Stainless Steel Refining

In the various refining technologies of stainless steel, the argon-oxygen decarburization (AOD) process has many obvious advantages; thus, it has been applied extensively and developed rapidly throughout the world [2]. At present, over 75% of the world's stainless-steel output is produced using the process. [20]

Table 5. Refining Process Waste.

Waste	Amount	Uses / Importance
EAF dust	10–30 kg/ton liquid steel*	Recycled Using sintering of a composite
Secondary refining slag	9–15 kg/ton liquid steel*	It helps in absorbing inclusions and impurities, thus producing cleaner steel.
AOD slag	~160 kg/ton liquid steel*	Can be used as aggregate in concrete
Casting process slag	4–5.7 kg/ton liquid steel*	-

*From reference 1,9

5.6. Waste During Casting and Rolling Mill

Casting and rolling are done to get closer tolerance to dimensions, during these processes some amount of surface material gets wasted.

Table 6. Casting & Rolling Waste.

Waste	Amount	Uses / Importance
Mill Scale	35–40 kg/ton of steel*	Have very less impurities
Mill Sludge	12 kg/ton steel*	Can be reused For Steel Making Process

*From reference 1,9

6. Hazardous Waste Coming from Steel Industries

It is observed that the steel slag from EAF to produce carbon steels is very similar to that from BOF [14]. However, the slag from EAF to produce alloy or stainless steels is quite different. It has a lower FeO content and a very high content of Cr, which leads to classifying the slag as a hazardous waste. [20]

7. Conclusion

Many wastes from industrial processes can serve as a substitute for iron ores or fluxes due to their chemical composition and properties. From the study it has been found that steel scrap, iron scales, metallurgical dusts and sludges, steel-making slag, etc. among the most frequently used reusable materials. Proportion of reusable material depends on the content of detrimental substances in this material. Steel sectors are one of the major waste producer, but they have developed various process by which most of the waste are again converted into economy. Getting value from a waste is always difficult, but it is the need and required to use those waste/scrap parts. Sectors are already running out of raw material therefor they have invented new technology to handle those waste for sustainable development.

Acknowledgements

The author would like to acknowledge his sincere thanks to his Parents and Faculties of Department of Metallurgical & Material's Engineering, OP Jindal University, Raigarh for their constant support.

The author would like to show his gratitude towards Mr. Chandrakant Sahu (Control & instrumentation Engineer) Prakash Industries Limited, and a special thanks to Mr. Judy Garland (Editorial assistant Science Publishing Group, USA) for making this article free publishing without APC.

References

- [1] *Sehlselo Ndlovu, Geoffrey s. Simate, Elias Matinde “*Waste Production and Utilization in the Metal Extraction Industry” CRC Press Taylor & Francis (ISBN-13: 978-1-4987-6729-3).
- [2] A. K. M. Rainbow “Reclamation, Treatment and Utilization of Coal Mining Wastes” ELSEVIER SCIENCE PUBLISHERS B. V (ISBN 0-444-42876-3 (Vol. 2)).
- [3] R. E. Hester, R. M. Harrison “ISSUES IN ENVIRONMENTAL SCIENCE AND TECHNOLOGY” Royal Society of Chemistry (ISBN: 978-0-85404-112-1).
- [4] Industrial Wastewater Management, Treatment “INDUSTRIAL WASTEWATER MANAGEMENT TREATMENT, AND DISPOSAL” McGraw-Hill (eBook-0-07-159238-5).
- [5] Attila Meggyes, Valéria Nagy “Biogas and Energy Production by Utilization of Different Agricultural Wastes” Acta Polytechnica Hungarica (Vol. 9, No. 6, 2012).
- [6] Abhishek Kumar Awasthi, Jinhui L “Management of electrical and electronic waste: A comparative evaluation of China and India” (Renewable and Sustainable Energy Reviews-76 (2017) 434 447).
- [7] Rohit Maurya, Umesh Kumar “Utilization Methods of Polymer Waste in Geotechnical Applications” International Journal of Scientific and Research Publications, Volume 5, Issue 10, ISSN 2250-3153.

- [8] Satadru Kashyap, Dilip Datta “Reusing industrial lime sludge waste as a filler in polymeric composites” *Materials Today: Proceedings* 4 (2017) 2946–2955.
- [9] Steel Authority of India Annual Report 2017.
- [10] Hongting Ma, Na Du, Zeyu Zhang, Fan Lyu, Na Deng, Cong Li, Shaojie Yu “Assessment of the optimum operation conditions on a heat pipe heat exchanger for waste heat recovery in steel industry” *Renewable and Sustainable Energy Reviews* (79 (2017) 50-60).
- [11] Ao Luo, Hao Fang, Jianjun Xia, Borong Lin, Yi jiang “Mapping potentials of low-grade industrial waste heat in Northern China” *Resources, Conservation & Recycling* (125 (2017) 335–348).
- [12] Aritra Das a, Chanchal Mondal “Studies On The Utilization Of Fruit And Vegetable Waste For Generation of Biogas” *Research Inventy: International Journal Of Engineering And Science* Vol. 3, Issue 9, PP 24-32.
- [13] Mikhail Rodionov and Toshihiko Nakata “Design of an Optimal Waste Utilization System: A Case Study in St. Petersburg, Russia” *Sustainability* 2011, 3, 1486-1509.
- [14] Rupali Baghel, Vatsala Chaturvedi, Bartik Pandel, Upendra Pandel “Utilization of Mining and Industrial waste: A sustainable approach” *Procedia Earth and Planetary Science* 11 (2015) 242 – 246.
- [15] Kanjan Upadhyay, Kumar Harshwardhan “Effective utilization of agricultural waste” *IJERT* ISSN-2278-0181.
- [16] Vasso Oreopoulou, Winfried Russ” *Utilization of By-Products and Treatment of Waste in the Food Industry*” Springer Science & Business Media, LLC (ISBN-13: 978-0387-33511-7).
- [17] Web (<https://sites.google.com/site/iilyear4/top-10-countries-that-produce-the-most-waste>).
- [18] Web (<http://www.steel.org/steel-technology/how-its-made/processes/processes-info/the-basic-oxygen-steelmaking-process.aspx?siteLocation=88e232e1-d52b-4048-9b8a-f687fbd5cdcb>).
- [19] Web (<http://www.steel.org/steel-technology/how-its-made/processes/processes-info/electric-arc-furnace-steelmaking.aspx?siteLocation=88e232e1-d52b-4048-9b8a-f687fbd5cdcb>).
- [20] Sushovan Sarkar, Debabrata Mazumder “Solid Waste Management in Steel Industry - Challenges and Opportunities”.
- [21] Web (<https://www.quora.com/What-exactly-is-solid-waste>).
- [22] Web (<https://www.quora.com/What-is-Waste-Management>).