

EAF SLAG PROCESSING IN MOBARAKEH STEEL COMPANY IN IRAN

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Introduction

Mobarakeh Steel Company hereinafter indicated as MSC is one of the largest steel plate producers in Iran and also in the Middle East, with a total production of about 7.2 million tons per year.

MSC consists of several plants such as ironmaking, steelmaking, hot and cold strip mill plant. In the ironmaking area, DRI (Direct Reduction Iron) is produced by MIDREX technology which is used as an input material for the steelmaking shop. In the steelmaking shop, steel is produced using the electric arc furnace technology (EAF) in which DRI and scrap are charged into EAFs and then melted. Annually about 1.8-2 MT of EAF slag is produced as a by-product of steelmaking.

Currently, there are two huge stack piles of EAF slag in MSC with an approximate quantity of 20 MT, which have good potential for valorising and a good resource for metal recovery and also use in cement industries, road construction, asphalt, concrete and so on.

During recent years, because of some environmental regulations and also for having a sustainable steel production, MSC decided to define some projects to decrease the undesirable environmental impacts of the slag and to convert it into eco-friendly products by special slag processing methods.

To this end, many efforts were done and as a first step, two types of slag processing were implemented. The first project was cold slag processing project and the second one molten slag processing project. In this paper the authors shall describe briefly the activities which have done in these projects to valorise EAF slag and will clarify the plan for the future.

EAF Slag in MSC

In Table 1, a typical chemical analysis of MSC EAF slag is shown. This slag is a class of basic slag and concerning the percentage of SiO_2 , Al_2O_3 and CaO contents of the slag, its composition is similar to that of Portland cement.¹

Table 1: A typical chemical analysis of EAF slag in MSC

SiO_2 (%)	CaO (%)	MgO (%)	Al_2O_3 (%)	MnO (%)	FeO (%)	V_2O_5 (%)
16-17	32-35	10-13	3-4	2-3	25-35	1.2-1.7

Depending on the ratio of charging materials (DRI/scrap), the chemical analysis of the produced slag may vary within a range. Because of the relatively high FeO contents of EAF slag, the usage of this slag in cement industries has been limited.

Many efforts have been done to reduce the FeO content in the slag (returning back Fe to the melt for increasing productivity and yield), but to have a foamy slag in EAF during melting (to decrease energy and electrode consumption), it is necessary to inject oxygen and carbon into the melt and it consequently results in more FeO in the slag. So reduction of FeO content in the slag to an optimum level, is one of the challenges that MSC is faced with.

EAF Slag Processing Projects in MSC

Currently, there are two huge stack piles of cold EAF slag with an approximate quantity of 20 MT (Figure 2) and it is estimated that at least 1 MT metal could be recycled from these depots. In MSC, for recovering of scraps and metals from slag, a cold slag processing unit has been established (Figure 1). After metal and scrap separating, the remaining slag is sorted in different sizes and it is used as aggregates for road construction and concrete.^{2,3}



Figure 1: a) Cold Slag Processing Unit and b) Top view of EAF slag stack piles

According to research conducted by the US Environmental Protection Agency, recycling scrap metals can be quite beneficial to the environment and sustainability

of steelmaking plants. Using recycled scrap metal in place of virgin iron ore can yield⁴:

- 75% savings in energy
- 90% savings in raw materials used
- 86% reduction in air pollution
- 40% reduction in water use
- 76% reduction in water pollution
- 97% reduction in mining wastes

Every ton of new steel made from scrap steel saves:

- 1115 kg of iron ore
- 625 kg of coal
- 53 kg of limestone
- 1 ton of CO₂ emissions

Hot slag processing is another environmental project in MSC in which the hot slag is cooled down and also granulated by an air and water injection system and converts EAF slag into different sizes of granules. This granulated slag is used in cement industries. A schematic of hot slag processing is shown in Figure 2.

Also, this project has succeeded to receive the Energy Globe certificate in 2013-2014. This certificate is awarded annually to successful sustainable projects focusing on energy efficiency, renewable energies, and conservation of resources and saving of natural resources.

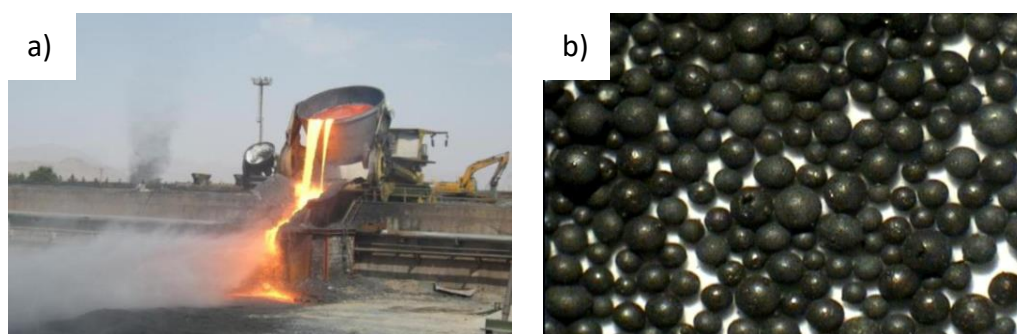


Figure 2: a) Hot Slag Processing Unit and b) Granulated EAF Slag

Results and Suggestions

In our opinion, despite the activities that have been done for slag recycling in MSC, but in comparison with the valorisation potentials that exist in MSC, it is still necessary to apply new methods and technologies to get more value from our EAF slag.

So, we would like to kindly welcome the experts and qualified companies in slag processing, to visit MSC site and help us to make suggestions for more valorisation of EAF slag. So MSC declares its readiness to receive techno commercial proposals of companies concerning the EAF slag processing and valorisation.

Of course, we have already received technical proposals from some outstanding companies on MSC slag processing such as *Primetals (Austria)*, *Ecofer (Finland)*, *Ecomaister (South Korea)* and *Bao steel (China)*, for which the investigations on proposals are in progress.

Also, MSC is ready to welcome all slag experienced companies and institutes to visit our slag processing unit and propose their ideas, projects and techno commercial proposals for better valorisation of our EAF slag and having sustainable steel making. Some of our guidelines for future negotiations with companies is summarised as follows:

- The companies preferably undertake the total financing which is needed for implementation of any slag valorisation project in MSC.
- There is the possibility for signing contract on the basis of BOT terms and condition. (Build, Operate and Transfer)
- Readiness of MSC for buying of Fe metals which is recovered from MSC slag.
- Readiness of MSC for collaboration on production and marketing of slag products for different applications. (Cement industries, road construction and so on.)
- Supporting for necessary utilities and infrastructures needed for the establishment of slag processing plants.
- Readiness of MSC to receive consulting services from companies.

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