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March Towards Green Steel Production-Efforts at Tata Steel

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ABSTRACT

The paper discusses the various initiatives taken by Tata Steel in the utilisation of waste materials generated in the blast furnaces, LD plants and rolling mills. In its drive towards total utilisation of wastes, the company is likely to become the first integrated green steel industry in our country.

Key Words : Green steel production, waste utilisation, BF slag, LD slag, mill scale, sludge.

INTRODUCTION

The cost and quality of hot metal plays an important role in determining the cost-competitiveness of the steel produced in an integrated steel plant. There are two basic approaches to combat the problems associated with the high cost of steel production.

- Re-utilise the wastes generated as substitutes of original raw materials. This would not only help in preserving the resources but also save the cost of raw materials by reducing their specific consumption.
- Convert wastes into wealth by using simple cost effective beneficiation techniques.

Considering the vast scope available, the major integrated iron and steel plants have now focused their attention on recycling and reusing their wastes. A "zero waste technology" drive is visible everywhere. Reduce, Recycle and Reuse have become the motto of the day. At Tata Steel, which has always been the forerunner in environment management activities, efforts are now focussed on not just recycling the wastes but also in 'adding value to it'.

The company has initiated a major solid waste utilisation drive and has bench marked itself against Hoogovens BV, Netherlands.

Majority of the wastes in an integrated steel plant are generated during the process of iron making. Blast furnace slag, sludge and flue dust together contribute to more than 50% of the waste generated. BF and LD slag together amount to 85% of the total waste generated. Total utilisation of slag and sludges alone would result in 90% waste utilisation. At Tata Steel efforts are being made for the complete utilisation of the BF and LD slag generated, which would result in substantial cost savings due to reduced specific consumption of raw materials. The paper describes the efforts made by Tata Steel in its march towards attaining a green industry status.

BF SLAG, FLUE DUST AND GCP SLUDGE

BF Slag

Granulated blast furnace slag, because of its cementing properties serves as an ideal admixture in cement making. One of the major breakthrough in utilization of BF slag is the Jojobera Cement Plant which utilizes 0.7-0.8 mtpa of granulated slag for cement making. Tata Steel was the first integrated steel plant to set up a cement plant exclusively for utilizing its blast furnace slag. The cement plant has now been taken over by M/s Lafarge of France. Granulated BF slag being glassy in structure and consisting of silicates and aluminates of lime and other basic constituents, is used mostly for making Portland slag cement . Tata Steel has a separate slag granulation and drying plant for the treatment of slag from three of its old blast furnaces. The slag from the other three blast furnaces and the “G” furnace are granulated at the cast house. Efforts are on to improve the granulation of BF slag in order to increase its glassy nature. This would increase the percentage of BF slag being utilized in cement making from present level of 55% to more than 60%.

BF Flue Dust and GCP Sludge

Utilization of the blast furnace gas produced during BF iron making calls for prior cleaning of the gas to remove most of the flue dust. During the cleaning process, the gas is passed through a dry dust catcher, where coarse particles (flue dust) are removed. After the separation of coarse particles, the gas generally goes to a wet cleaning system where fine particles of dust are scrubbed out of the gas with water and termed as GCP sludge. While recycling this dust / sludge through sinter plant is common practice elsewhere, the same is prohibitive at Tata Steel, primarily because of its high alkali content (0.6 - 0.9%).

A process route was developed at R&D Division, Tata Steel to utilize these wastes ejected from the blast furnaces. The process envisages production of two value added products viz. - heavy media for use in coal washeries and a recyclable material for the sinter plants.

Blast furnace flue dust contains 0.78 to 0.87% total alkali (Na_2O & K_2O), 37% Fe (t) and 24% carbon. GCP sludge contains 0.54% total alkali, 35.6% Fe (t) and 26% carbon. A process comprising two stage magnetic separation (First stage at 500 gauss and second stage at 20,000 gauss) followed by selective chlorination of second stage magnetic fraction was found to be capable of de-alkalifying the flue dust and GCP sludge.

Processing of flue dust resulted in a product of specific gravity 4.03 with good magnetic properties at a yield of 30% while GCP sludge gave a magnetic product of similar specific gravity at a lower yield of about 8%. Both these products can be used as an alternative heavy media in coal washeries along with natural magnetite being used now. Another product recyclable to the sinter plant with 0.21% alkali at a yield of 50% (composite of selective chlorination product and non-magnetic fraction obtained at 20,000 gauss), was also obtained from the flue dust. GCP sludge also gave a similar product containing 0.19% alkali at a yield of 66%.

Studies with 3" dense medium cyclone with both magnetic fraction of flue dust (MFFD) and conventional magnetite showed an improvement in clean coal yield with MFFD. After successful plant trials, efforts are now on to use the MFFD as a heavy media in the coal washeries on a regular basis.

LD SLAG AND SLUDGE

LD Slag as Sinter Grade Fines

The LD slag is highly basic and contains iron-bearing materials. In order to remove iron bearing materials, the entire LD slag is processed through a Waste Recycling Plant (WRP) for recovery of iron. The non-magnetic fraction i.e. the waste from WRP plant is used in the sinter plant due to its high CaO content. However, its phosphorus content is a restriction for its higher utilization. Examination of the LD slag by XRD revealed the presence of di-calcium and tri-calcium silicate (both weakly magnetic) as well as calcium ferrites (strongly magnetic) phases. The phosphorus was found concentrated mainly in the first two phases. The magnetic intensity used for separation of the metallics was increased. With increased magnetic intensity, the CaO level of the sinter grade fines increased substantially as the weakly magnetic calcium-silicates were attracted in larger amounts. While this effort brought in extra phosphorus, the P/CaO ratio in the sinter grade fines became more favourable.

The studies are also under progress at Tata Steel to reduce the phosphorus level of LD slag by treating the liquid slag with exothermic reducing additives. The process also produces pig iron which can be used as a substitute of ferro phosphorus.

LD Slag as Soil Conditioner

Considering the availability of large area of acidic soil in the vicinity of Jamshedpur, the use of pulverized LD slag is one of the attractive proposals for soil conditioning after processing in WRP. On experimental basis the LD slag was processed and pulverized to optimal fineness. The pulverized slag contains 88% fraction below 0.15 mm and the balance is -0.21 + 0.15 mm. With the assistance of the Rural Development Group, this slag was used as soil conditioner and fertilizer in growing vegetables and wheat. The result obtained was quite satisfactory with an increase in yield from 30 to 60%.

LD Sludge as Sinter Feed

LD sludge which is generated by cleaning of LD converter consists of 56-60% Fe and about 0.4% alkali besides an unfavourable moisture content of about 36%. It was found that the addition of sludge at a rate of 20-23 kg/ton of sinter during sintering would consume the entire quantity of LD sludge. The addition of sludge would increase the alkali input in the sinter from 0.15 to 0.156% which is insignificant. However, the higher moisture content (36%) of this sludge was the major problem in use of the sludge in the sinter plant.

With this in view, studies were carried out to evaluate the dewatering characteristics of LD sludge with/without lime addition with an objective to reduce the surface moisture and make it flowable through bins, feeders etc. The studies showed that when the lime addition reached a level of 30%, the moisture reduced from 36 to 13.6% and the material became granular.

Based on the above studies, LD sludge is already being used in sinter plants. LD slag is being used as a replacement of lime as the lime content in LD slag is very high and in addition it also serves as iron source to the sinter.

MILL SCALE AND SLUDGE

During rolling of steel in the rolling mills, coarse mill scale and fine oily mill scale get generated. The present generation of the oily mill scale at Tata Steel popularly known as the mill sludge is around 10,000 tpa and that of the coarse mill scale around 90,000 tpa. While the +6mm mill scale is used directly in the blast furnaces, and the −6 to + 3 mm in sinter plants, the mill sludge containing 10-20% oil is dumped as waste. Studies were carried out at R&D Division, to find out avenues for utilizing the mill sludge economically. Briquetting studies using molasses and hydrated lime as the binder showed that it would be possible to produce briquettes of sufficient strength for feeding into the blast furnaces directly. Studies for use as heavy media also showed that the mill sludge could be successfully used in place of magnetite as heavy media in coal washeries. The means of using it in its coal washeries is being explored.

By using the mill sludge and the MFFD, Tata Steel would be able to meet its requirements of heavy media completely from wastes generated in the plant.

CONCLUSIONS

With such initiatives, Tata Steel proves to be a forerunner in phasing out pollution prone processes and in installing state-of-the art and environmental friendly processes. By continuing its drive towards total utilization of wastes, it would not be long before Tata Steel becomes the first green steel industry in the country and one of the best in the World in terms of lowest cost of steel produced.