Researches on Assessment of Recycling Potential of Dusts from Electric Steel Mills

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Abstract. The paper presents an assessment of the recycling potential of dusts from electric steel mills. It is presented the equipment used to determine the recycling potential of dust and results from the review of the dusts emitted to the carbon steelmaking.

Keywords: dusts, electric arc furnace, electric steel mills, pollution, recycling, steelmaking,

INTRODUCTION

Steelmaking process in the electric arc furnace is a very significant source from generation of the dusts. The quantity of the dusts generated in the electric arc furnace steelmaking process depends on the furnace capacity. In the Tab. 1 is presented the quantity of the particulate matter derived from the steelmaking in the electric arc furnace (Iluțiu – Varvara, 2007 and Varvara, 2006).

Studies on the quantities of dust emitted by electric arc furnaces shows that during the steelmaking processes are issued between 15 - 25 kg dust / tone of steel produced (Guézennec et al. 2005 and Huber et al. 2001).

In accordance with the classification made by the United States Environmental Protection Agency in 1980, dust from steelmaking in the electric arc furnace is part of the category of hazardous waste because it contains lead (> 5ppm), cadmium (> 1ppm) and chromium (> 5ppm). In the United States the amount of dust generated annually from carbon steelmaking in electric arc furnace is constantly increasing, and in 2000 it was 900,000 tones (U.S. E.P.A., 1995).

The investigations effectuated about the compositions of the dusts originated from the steelmaking in the electric arc furnace, showed that in the composition of these are present: iron oxide (FeO), zinc oxide (ZnO), lead oxide (PbO), manganese oxide (MnO), magnesia oxide (MgO), cooper oxide (CuO), alumina (Al₂O₃), chromium oxide (Cr₂O₃), etc.
MATERIALS AND METHODS

The analyzed dusts were taken from an electric arc furnace, having a capacity of 75 tones. The installation of a burned gas treatment plant with content of dusts, emitted during steelmaking in electric arc furnace, consists of: fixed elbow on the furnace vault; extraction mobile elbow on the primary circuit; post-combustion chamber, chilled pipe on the primary route, atmospheric air cooler (forced air cooler); sparks separator, bags-house filter; exhausters (main fans); funnel; chains for dust transport; elevator with cups; dust silo; dust pelletizer (pelletization installation); storage container for compressed air used by the circuit of the bags shaking, air dryers - processes the impurities and humidity out of the compressed air; extraction piping on the secondary circuit.

To determine the concentrations and composition of the dusts is was used the followings: laboratory glassware, analytical balance, platinum crucible, dust removal pumps of type Sartorius – debit-meter (0 – 20 l/min) with lengthening of 7 (mm), speed-meter - Pitot Prandtl tube with direct reading and the sequential measurement scale in the range of 0-50 (m/s). The measurements were made at the filter entrance.

The recorded parameters for the 5 probes are presented in the (Tab. 2).

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Measurement unit</th>
<th>Probe 1</th>
<th>Probe 2</th>
<th>Probe 3</th>
<th>Probe 4</th>
<th>Probe 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probe Diameter</td>
<td>(mm)</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Harvesting debit</td>
<td>(l/min)</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>12.5</td>
</tr>
<tr>
<td>Harvested air volume</td>
<td>(l)</td>
<td>70</td>
<td>70</td>
<td>70</td>
<td>70</td>
<td>62.5</td>
</tr>
<tr>
<td>The weight of the dust deposited on the filter</td>
<td>(mg)</td>
<td>21.6</td>
<td>16.2</td>
<td>19.2</td>
<td>20.4</td>
<td>21.6</td>
</tr>
</tbody>
</table>

RESULTS AND DISCUSSION

In (Fig.1) are presented the dust concentrations before the de-dusting plant for the 5 probe.

![Fig.1. The dust concentrations before the de-dusting plant for the 5 probe](image)

In Fig. 2, 3, 4 and 5 there are presented the percentage compositions for four types of charges, of the dusts from carbon steelmaking in the electric arc furnace.

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In Fig. 2 and 3 it is shown that in the composition of dusts prevails $Fe_2O_3$, FeO and CaO. The percentage composition of these oxides in the dusts is mainly influenced by the quality and composition of charge.

Fig. 2. The percentage composition of the dust in the carbon steelmaking, of the charge 1

Fig. 3. The percentage composition of the dust in the carbon steelmaking, of the charge 2
In Fig. 4 and Fig. 5 it is shown that in the composition of dusts prevails $Fe_2O_3$, $Fe_3O_4$, FeO and CaO.

In the analyzed dusts composition (charge 3 and 4) there are also found oxides of heavy metals (PbO, ZnO).

The dusts composition emitted during steelmaking in the electric arc furnace depends mainly on the charge quality and on the presence of certain impurities in the charge.

![Fig. 4. The percentage composition of the dust in the carbon steelmaking. of the charge 3](image1)

![Fig. 5. The percentage composition of the dust in the carbon steelmaking. of the charge 3](image2)
CONCLUSIONS

The dusts composition emitted during steelmaking in the electric arc furnace is dependent on a number of factors, such as: brand of steel that is developed; temperature, which can cause volatilization of some heavy metals (Pb, Cd, Zn, Ni, etc); type of refractory lining of the electric arc furnace (acidic or basic); composition and quality of charge; presence of certain impurities in the charge.

Because of the high quantities of the dusts emitted during steelmaking in the electric arc furnace the following are necessary:
- recycling the dusts;
- decreasing the dust quantity emitted;
- chemical stabilization of dusts;
- re-utilizing the dusts like charge.

The dusts generated during the carbon steelmaking tend to be rich in zinc and lead. Among the exiting oxides in these dusts emitted during steelmaking, the inhalation of:
- \( Fe_3O_4 \), \( Fe_2O_3 \) and FeO causes the disease known as siderite;
- \( SiO_2 \) causes the disease known as silicosis;
- PbO at the beginning has irritant effects and causes insomnia, after which appear states of distress and depression. Later, the symptoms lead to disturbance in the nervous system and damage of the brain, liver and kidneys.

The dusts composition emitted during steelmaking in the electric arc furnace is varying very broad in terms of the quality waste used and of the other components of the charge.

The dusts from the electric arc furnace are composed mainly of:
- metallic oxides;
- oxides of refractory materials;
- volatile elements from the charge of the aggregate.

In conclusions, in the dusts emitted during the steelmaking process in the electric arc furnace, there are compounds that can be recycled.

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