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Steelmaking Slag Beneficiation by Magnetic Separator and Impacts on Sinter Quality
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Abstract: Basic oxygen furnaces (BOF) slag is the main problem at all iron and steel factories. About more than 6 million tons/year of BOF slag has been accumulated from the waste stockyards in Turkey. Dumps slags can be revaluated by a processing technology which makes it possible to obtain products that meet the requirements of sintering and blast furnace production. The slags with particle size of -10 mm were enriched by the magnetic separator resulting and increase in Fe grade from 18% to 33%. The use of BOF slag in sinter blend provided additional Mn, CaO, MgO and introduced a good solution to environmental problems.

Keywords: Basic Oxygen Furnaces Slag, Sinter, Solid Waste, Tumbler Index, RDI.

1. Introduction

Slag is not a mined material and thus the concept of reserves does not apply to this mineral commodity. Production processes in iron and steel industry involve the formation of large amounts of by-products. These by-products cause large volumes of waste streams. The recovery of metals from these by-products, for example dusts and sludge, becomes more and more important as legal requirements demand a thorough utilization, existing landfill capacities as well as the scarcity of primary resources and in the long term the rising prices of metals make such utilization economically attractive [1, 2]. Slag production data for the world are unavailable, but it is estimated that annual world iron slag output in 2013 was around 270 to 320 million tons, and steel slag about 140 to 220 million tons, based on typical ratios of slag to crude iron and steel output [3]. Dumping of these wastes has problems starting with the limited area to store and deterioration of the environment is also another factor to be considered [4]. Steel slag is a solid waste from steel production. It can be categorized as carbon steel slag and stainless steel slag according to the type of steel, and as pretreatment slag, basic oxygen furnace slag (BOFS), electrical arc furnace slag (EAFS), ladle refining slag (LFS) and casting residue according to the steelmaking process [5].

The dust, sludge and steelmaking slags (BOF slag) from steel factories should be well assessed considering the effective use of sources with the economic and environmental factors. The larger the amount of by-products occurs during steel production, the more precautions and obligations are put into account for steel factories in many countries in environmental aspect [6, 7].

Approximately 1.5 million tons of steel is produced in iron and steel industry in a year which corresponds to an estimated amount of 600 million tons of solid waste and slurry dust. According to many researches in this field, during production of 1 ton of steel approximately 400 to 450 kg of solid waste is produced [8, 10]. These solid wastes generally
consist of 250-300 kg slag from blast furnace and about 100-150 kg from steelmaking slag and rests of them are dusts, sludge, mill scale, refractory materials etc. [11, 12].

The trend in recent times is using the slag in steelworks with maximum proportions. When compared to blast furnaces slag, BOF slag usage has improved significantly [13]. BOF slag consists of calcium silicate and alumina-ferrite composed of mainly form of melting calcium, iron, magnesium and manganese oxides. Depending on the features of steel, the chemical composition of BOF slag may differ. The main aim of the steel industry turns out to be providing the maximum benefit from steelmaking slags [14].

Sintering can be defined as the bonding of particles consisting of one or more components in a mass of crystalline or amorphous powder, in a loose or green compact form, at atomic level by the application of energy, single or in combination with other, through external means, resulting in improvement in one or more properties due to the associated structural modifications [15].

The slag with the size of -10 mm is not exposed to magnetic separation and conveyed into the sinter blend. Various studies related to utilizing the BOF slag through sinter making have been done and summarized the methods of slag making [16]. A sinter plant, which was originally developed to convert the iron ore fines into a desirable blast furnace feed further, offers very potent route of recycling for a large number of wastes in various quantities [12]. Steel slag with CaO content above 50% can be used as sinter ore fluxing agent, partially replacing the commercial lime. The slag addition can improve the quality, reduce fuel consumption due to the heat liberation of Fe and FeO oxidation reaction and decrease the cost of sinter ore [17]. More than 56% and 24% of the produced steel slag have been utilized as sinter material in USA and German respectively [6]. In China, Baoshan Iron and Steel Group (Bao Steel) began to reuse steel slag for sintering in 1996, now having a stable reusing amount of 15,000 tons [18]. Lianyuan Iron and Steel Company (Lianyuan Steel) have been utilizing steel slag as sinter material while in recent years the amount for sintering has decreased because of either the increase of phosphorus content in iron ore and hot metal or the decrease of CaO and Fe content in steel slag [19].

The fine ore to be sintered is moistened and fed to the sinter machine together with coke dust and additions such as limestone, quick lime, dunite and/or dolomite. BOF slag may be added instead of flux material to adjust the basicity.

The process of sintering serves to three main purposes. One of them is agglomerating the fine iron ores to suitable sizes to be used in the blast furnace. The other is decreasing the existing sulphur in iron ores by oxidizing. The third one is producing charge materials that show high reducibility, strength and resistant to crumble, to put in other way, suitable to be used in the blast furnaces [20]. Since converter slag is a calcined material, loss of ignition is low, so in a way, converter slag is a low-grade sinter [8].

In companies which charge higher rate of sinter in blast furnaces it will be more advantageous to use the enriched BOF slag [21, 22]. The addition of BOF slag fulfills the sinter flux requirement in the sinter blend with also providing the recovery of significant amount of Fe and Mn from the waste [23].

With respect to chemical characteristics, slag of the 0-10 mm fraction is better than sintered ore, since it behaves as iron ore material and flux simultaneously. When BOF slag is used in the charge, additional heat is not needed to decompose limestone and mineral formation; the melt forms faster and easier; and the structure of the agglomerate becomes more homogeneous [5, 11]. This leads to a reduction in solid fuel consumption and a rise in reduced solid fuel consumption, since heat is released while oxidizing. The solid fuel saving of introducing 1 kg of metallic iron into the charge is 0.2 - 0.3 kg. When BOF slag is introduced into the sintering charge, the contents of magnesium and manganese oxides rises. This helps to improve slag conditions in the blast smelting and reduce the sulfur content in the pig iron. The tests conducted did not reveal any serious factors limiting the consumption of BOF slag in the sintering charge [24].
In this research article, the beneficiation of steelmaking slag with magnetic separator and its impact on quality of sinter, the usage of waste as flux of sintering and the effects of total ferrous material savings were investigated.

Iron and steelmaking slags are defined as the solid material resulting from the interaction of flux and impurities in the smelting and refining of steels. It is a by-product of steel making and is produced during the separation of the molten steel from impurities in steel making furnaces. That is, the slag occurs during steel making in liquid state. It is a complex solution of silicates and oxides that solidifies during cooling [4, 18].

The oxygen blowing into the convertor causes the oxidation and removal of undesired elements in the convertor. The occurring oxides combine with the flux materials and together form the molten slag which stays on top of the liquid steel in the converters due to density differences. BOF slag particles form in irregular shapes with rough surfaces and dark gray in color [6, 13].

BOF slag mainly consists of CaO, MgO, SiO$_2$, and FeO. The total concentration of mentioned oxides in liquid BOF slag is approximately 90%. In this manner, the BOF slag shall be defined as a quartet system of CaO-MgO-SiO$_2$-FeO. There always exist some undissolved lime pieces in the slag. [20]. In iron and steel production, the BOF slag occurred during liquid crude iron conversion mainly consists of %14-24 Fe, %5-14 SiO$_2$, %30-50 CaO, %2.5-5.5 MnO, %2.0-4.5 MgO and % 1.35 max P$_2$O$_5$. Only the phosphorus among these oxides has negative affect on iron and steel production [14, 22]. The amount of burnt lime increases due to the increase in the silica amount in the slag. Besides, the increase in the amount of MnO causes the slag volume and slag fluidity increase simultaneously which lead up to a decrease in efficiency of the blast furnace [22].

According to literature, nearly 180 kg of BOF slags emerge during 1 ton of steel production. The chemical compositions of these slags differ according to the charged raw material, type of steel and operating parameters. During the processing of 1 ton of hot ore, 45 kg of slag skull, 125 kg of BOF slag, 12.5 kg of overflown slags, 18 kg of pot remains and 15 kg of desulphurization slag are formed in an integrated iron and steel factory [14].
2. Experimental Studies

Steel making slags are processed by standard methods common to the sand and gravel industry, such as crushing and screening. Typically, the slag materials that are larger than 2.54 cm in diameter are very highly metallic, and are recycled as scrap. Additional processing could be integrated that would allow the recovery of iron units. Gravity, size, and magnetic separation techniques could be designed into flow sheets for recovering the iron units. The resulting fine scrap concentrate could then be pelletized and recycled into the blast furnace [26, 27].

Steelmaking slag samples used in this study were provided from an integrated iron and steel slag processing plant comprising various crushing and screening units (Fig. 2). Slags taken from various production dates were examined in terms of their chemical compositions, and as a result, the slag compositions were found to be very similar with a slight divergence. The ferrous part in the slag was sieved into 4 different particle sizes (-10 mm, +10 -48 mm, +48 -55 mm, +55 mm) and stocked separately.

The classified ferrous material with the size of +55 mm is carried to the scrap preparation plant of the steelmaking plant. The ferrous material with the size of +48 -55 mm is stocked and stays idle. The +10 -48 mm part of the material is used in blast furnaces. The fine part of the ferrous material (-10 mm) was fed to the BOF slag enrichment plant with magnetic separators (Fig. 3). Analysis of the results indicates that the use of BOF dump slag of the -10 mm fraction in the sintering charge improves its high temperature properties. In addition, the -10 mm fraction is added into sinter mixture as source of iron and fluxing materials.

![Fig. 2. The BOF slag screening plant flowsheet.](image1)

![Fig. 3. The magnetic separator enrichment flowsheet of -10 mm ferrous material.](image2)
The blending experiments were conducted in three stages as with BOF slag, with enriched BOF slag and without any BOF slag and, using the -10 mm fraction of the ferrous material that has Fe content of 17-24% into the BOF slag without any magnetic separation process and with magnetic enrichment.

2.1 Studies with Laboratory Scale Magnetic Separator

The magnetic separation method is used for separating metallic iron and iron minerals from steel slag. Commonly used magnetic machines are the cross-belt magnetic separator, drum magnetic separator and magnetic pulley separator. No one system or type of magnet can be used for all ferrous waste recovery. Above all, the system must initially be engineered into the process to provide recovery of a product that is required [28].

The beneficiation possibilities of representative samples of the BOF slag were investigated. Firstly, particle size distributions and chemical contents analysis were performed. Eight samples (analysis of sinter blends12, 15, 18, 20, 22, 25, 28, 32; S1-S8) with grain size -10 mm were collected from a steelmaking slag collection and processing plant. The determination of particle size distribution and chemical analysis of the samples were completed at first (Tab. 1).

Tab. 1 Chemical composition of iron and phosphorus of different particle size fractions in the slag

<table>
<thead>
<tr>
<th>Particle Size Fraction (mm)</th>
<th>% Weight</th>
<th>% Total Fe</th>
<th>% FeO</th>
<th>% P</th>
</tr>
</thead>
<tbody>
<tr>
<td>+5</td>
<td>18.75</td>
<td>29.43</td>
<td>13.78</td>
<td>0.32</td>
</tr>
<tr>
<td>-5+3</td>
<td>20.46</td>
<td>25.85</td>
<td>1.24</td>
<td>0.29</td>
</tr>
<tr>
<td>-2+0.5</td>
<td>27.82</td>
<td>22.96</td>
<td>8.12</td>
<td>0.26</td>
</tr>
<tr>
<td>-0.5+0.1</td>
<td>23.26</td>
<td>15.84</td>
<td>6.25</td>
<td>0.28</td>
</tr>
<tr>
<td>-0.1</td>
<td>9.71</td>
<td>11.84</td>
<td>3.02</td>
<td>0.14</td>
</tr>
<tr>
<td>Total</td>
<td>100.00</td>
<td>22.03</td>
<td>6.84</td>
<td>0.27</td>
</tr>
</tbody>
</table>

The tests revealed that the coarse fractions have the highest Fe content. The slag samples contain an average of 22.03% Fe and 0.27% P. Magnetic separation tests were applied to slag samples to study further beneficiation possibilities. Thus, as a result of magnetic separation the metallurgical properties of BOF slag as sintering material can be improved. Example, the iron content is raised and the amount of harmful impurities is reduced, particularly chromium and silicon oxides [24].

![Fig. 4. Flowsheet of magnetic separation test application.](image)
The representative sample was beneficiated by a laboratory scale magnetic separator in 400 gauss magnetic field force and the non-magnetic part of sample was treated in 1000 gauss magnetic field force in order. As a result, a 400 G magnetic product, a 1000 G magnetic product and waste were gathered after the experiment (Fig. 4) and analyzed according to their weight percentage, total Fe content, FeO content and P content (Tab. II).

Tab. II Chemical composition of iron phase and phosphorus obtained from two-step magnetic separation test

<table>
<thead>
<tr>
<th>Particle Size Fraction (mm)</th>
<th>% Weight</th>
<th>% Total Fe</th>
<th>% FeO</th>
<th>% P</th>
</tr>
</thead>
<tbody>
<tr>
<td>400 G Magnetic</td>
<td>17.34</td>
<td>57.48</td>
<td>3.02</td>
<td>0.17</td>
</tr>
<tr>
<td>1000 G Magnetic</td>
<td>21.35</td>
<td>24.45</td>
<td>5.47</td>
<td>0.32</td>
</tr>
<tr>
<td>Non magnetic</td>
<td>61.31</td>
<td>11.64</td>
<td>5.68</td>
<td>0.21</td>
</tr>
<tr>
<td>Feed - Slag</td>
<td>100.00</td>
<td>22.32</td>
<td>5.17</td>
<td>0.23</td>
</tr>
</tbody>
</table>

The results state that, in 400 G magnetic field 17.34% of the slag is the magnetic product with 57.48% Fe content with 36.25% recovery. FeO contents are observed to decrease from 5.17% to 3.02%, while metallic iron productivity is 71.23%. Approximately 90% of P remained in the non-magnetic product. The second phase of magnetic separation in 1000G was able to gather 21.35% of the material with 24.35% Fe content and a concentrated P of 0.32%. At the situation when magnetic separation is carried out at 1000G in single phase, approximately 60.23% recovery with 37.45% of Fe content was determined. In the separated product which was eliminated by magnetic separation Fe productivity is 91.50% and FeO content was analyzed as approximately 27%.

2.2 Applications of pilot plant scale magnetic separator

A preliminary test is conducted by using a series of hand held magnets with various magnetic field force values at laboratory scale to see whether this process could be effectively applied to separate magnetic grains. Representative samples taken from steelmaking slag were sent to a different iron and steel plant to determine if the BOF slag separated as magnetic and non-magnetic products could be used effectively to obtain an iron-containing flux material for sinter by experimenting different blade gaps and various the magnetic field intensities (600-1200 G).

![Magnetic separator working principle](image-url)
After determining the appropriate magnetic field force values, it will be possible to design and use for industrial scale. In this system (Fig. 5), the parameters affecting the separation process are slag grain size, drum revolution speed, drum radius, drum flesh thickness, the gap between the drum and blades and magnitude of the magnetic field applied. The particle size distribution and accordingly the weight of the masses would change with the spinning distance determined by the centripetal forces.

The experimental practiced conducted with 1200 G magnetic field intensity stated that at that intensity 64.46% of Fe by weight can be concentrated by a low grade of Fe (28.57%). The experiments were focused on 1000 G magnetic field intensity and results are listed in Tab. III.

<table>
<thead>
<tr>
<th>Products/1000G (50 rpm &amp; 35 mm) % Weight % Fe % Recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concentrate for sinter material 44.76 30.48 58.58</td>
</tr>
<tr>
<td>Waste 55.24 17.46 41.42</td>
</tr>
<tr>
<td>Feed 100.00 23.29 100.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Products/1000G (50 rpm &amp; 25 mm) % Weight % Fe % Recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concentrate for sinter material 40.54 37.16 61.23</td>
</tr>
<tr>
<td>Waste 59.46 16.04 38.77</td>
</tr>
<tr>
<td>Feed 100.00 24.60 100.00</td>
</tr>
</tbody>
</table>

Approximately 44.76% of the feed passes through the blades with 35 mm distance with Fe content of 30.48%. On the other hand, the percentage of the passing material decreases through the blades with 25 mm distance to 40.54% by weight with an increasing Fe content of 37.16%. According to these experimental results the concentrated BOF slags can be used as iron bearing flux material in sinter blends [30]. A slag concentrate of 30% by weight with 35% Fe grade can be beneficiated from BOF slags by using a magnetic separator with 1000G magnetic field intensity.

2.3 Chemical and Mineralogical Characterization

Phase determination of -10 mm steelmaking slag and sinter samples containing slag were subjected to X-ray diffraction studies and mineralogical investigation under an optical microscope with to determine the phases existing in their structures. X-ray diffraction pattern of the -10 mm slag fraction is illustrated in Fig. 6. Steelmaking slag is mainly composed of FeO (wustite), 2CaO.SiO$_2$ (dicalcium silicate) and various CaO-FeO-SiO$_2$ solid solutions like CaFeSiO$_4$ (ferro-monticellite). X-ray diffraction patterns of sinter samples containing BOF slag were found to be similar and were stated in Fig. 7.

The results of the X-ray diffraction studies together with the results of mineralogical studies conducted on sinter samples containing BOF slag indicated that addition of slag into the sinter blend at samples did not change the mineralogical structure of the sinter and that all sinter samples contain magnetite (Fe$_3$O$_4$), hematite (Fe$_2$O$_3$), wustite (FeO), ferro-monticellite (CaFeSiO$_4$), dicalcium silicate (Ca$_2$SiO$_4$), calcium ferrites (CaFe$_5$O$_7$, Ca$_4$Fe$_{14}$O$_{25}$) and an amorphous glassy phase [31].
Fig. 6. X-ray diffraction pattern of the -10 mm steelmaking slag containing CaFeSiO$_4$, MgFe$_2$O$_4$, FeO, Ca$_2$SiO$_4$, Ca$_3$Si$_2$O$_7$, K$_2$MgSi$_3$O$_{12}$ and K$_2$MgSi$_3$O$_{12}$.

Fig. 7. X-ray diffraction pattern of the sinter added steelmaking slag containing Fe$_2$O$_3$, Fe$_3$O$_4$, FeO, CaFeSiO$_4$, Ca$_2$SiO$_4$, CaFe$_2$O$_7$ and MgSiO$_3$.

The sinters were observed to be very heterogeneous, as can be seen from the microstructures of the sinter samples presented in Fig. 8a and 8b, possibly due to the relatively coarse grain size of some raw materials, the limited diffusion possible during the short period at melt conditions and variations in the peak temperature reached. Microscopic examinations of those sinters showed that after low temperature breakdown testing, the only phase undergoing reduction is hematite and this causes micro cracking in the matrix surrounding the hematite [4, 32]. The morphology of the different phases in the sinter was demonstrated by SEM (Scanning electron microscopy) in Fig. 9a and 9b.
4. Results and Discussion

The technology for processing BOF slag should be aimed at obtaining products with increased iron content. The difference between the physicochemical properties of fractioned BOF slag and traditional iron ore materials also requires changes in the technology for using in sintering production. It is necessary to determine the maximum possible and also the optimum consumption of BOF slag in the sintering, taking into account its effect on the quality of the agglomerate, technical and economic indices of their production [16, 24]. Trials of sinter production were conducted without BOF slag, with direct usage of BOF slag and with enriched usage of BOF slag.

According to trials, the use of BOF slag increases from 15 to 70 kg/tss (kg per ton of skip sinter) after enrichment. Besides, the ferrous material tends to decrease with increasing usage of -10 mm BOF slags in the sinter blend and it can be observed that the Fe content remains constant. The amount of total ferrous material used for every 1 ton of skip sinter decreases from 1020 to 980 kg by using BOF slag and to 930 kg by using enriched BOF slag (Fig. 10).
Fig. 10. The changes in total ferrous material in sinter dependent on BOF slag and enriched BOF slag usage in sinter blend.

The use of flux material decreases with increasing usage of -10 mm BOF slag and the decrease is more obvious with increasing usage of enriched BOF slag. The amount of flux material to be used decreases from 220 kg/tss to 130 kg/tss for the production of every 1 ton of skip sinter (Fig. 11).

Fig. 11. The alteration of consumption for flux material with BOF slag and enriched BOF slag usage in sinter blend.

In particular, the increased basicity of BOF slag makes it possible to remove limestone from the charge and reduce coke consumption, while increased contents of MgO and MnO provide for a reduction in the slag’s basicity and a rise in its desulfurizing ability. The presence of metallic iron in the slag decreases coke consumption for reducing and melting it [16, 24].

The increasing use of -10 mm BOF slag also enhances the use of waste materials in the blend and this increase is higher when enriched BOF slag is used. The approximate usage of waste material for every 1 ton of skip sinter rises from 25 to 80 kg by using BOF slag. The use of enriched BOF slag increases the stated amount to 130 kg (Fig. 12).

There are huge amounts of coke fines produced inside the integrated iron and steel plant during coke transportation, handling and crushing of coke for use in the sintering
process [33]. Many researches stated that, with the use of BOF slag, the coke breeze in sinter blend decreases [5, 10, 26]. However, the mentioned decrease was not observed while using BOF slag. A negative factor with the use of BOF slag is an increase in contents of phosphorus and chromium in the agglomerate and pig iron, and the amount of iron in the agglomerate and blast furnace charge [24].

![Fig. 12. The changes in waste material amount and Fe grade dependent on BOF slag and enriched BOF slag usage in sinter blend.](image)

The change in the strength of sinter regarding addition of slag was also investigated. Tumbler index slightly decreased with increasing FeO content. The sinter strength may be affected by many factors. The usage of -10 mm BOF slag increased the tumbler index of sinter (+6.35 mm), the value increased higher by using enriched BOF slag as well. The tumble index for the sinter has raised form 65% to 70% with BOF slag addition and to 72% with enriched BOF slag addition (Fig. 13).

![Fig. 13. The behavior of the tumbler index of sinter (+6.35mm) and productivity (t/m².24h) dependent on BOF slag and enriched BOF slag usage in sinter blend.](image)

The slight decrease in the hematite content may have caused this increase in tumbler index of the sinter. Under the conditions of the low temperature breakdown test only the reduction which can occur in iron ore sinters containing high proportions of hematite degrade to a much greater degree than those, which are essentially composed, of magnetite and glass. The
degradation after reduction is considered to be due to the weakening of the structure caused by volume expansion, which occurs on the formation from hematite.

As -10 mm BOF slag and enriched BOF slag amounts increase in sinter blend separately, sinter specific capacity value also increases. The sinter specific value or productivity increases from 25 t/m²·24h to 29 t/m²·24h with BOF slag and to 39 t/m²·24h with enriched BOF slag (Fig. 13).

5. Conclusions

The effect of BOF slag and enriched BOF slag addition into the sinter blend was investigated in different aspects. The experimental tests showed that the use of BOF slag reduces the solid fuel consumption in sintering as well as the coke consumption in blast furnaces. The most efficient way of using BOF slag in sintering was determined by experimental studies including magnetic separator beneficiation parameters, chemical and mineralogical properties, metallurgical properties and their optimum combination. In this study, the effect of enriched BOF slag addition into the sinter blend was investigated with regard to basicity adjustment and influence on industrial sinter quality. The results stated that the amount of BOF slag addition into the sinter blend both increases the sinter productivity and general sinter quality.

The Fe content of the coarser particle fractions (+0.5 mm) is higher than finer fractions. The 67% of the slag is in +0.5 mm fraction by weight with Fe grade of 26%. Phosphorus is accumulated in coarser fractions as well. The optimum magnetic field intensity was found to be 1000 G in laboratory magnetic separation tests. During industrial pilot scale tests conducted in 1000G magnetic field intensity, the obtained Fe grade was 37.45% with 60.23% recovery. The results proved that approximately 61.23% of the slag can be enriched by weight with 37.16% Fe content and can be used 9.0% in the sinter blend by weight as a starter.

In the condition of increasing BOF slag in the sinter blend from 15 kg to 70 kg, the slag in the sinter blend increased from 2.3% to 9.0% but that didn’t affect the Fe grade. On the other hand, the increase in the amount of waste from 25 kg/tss to 130 kg/tss affected the amount of total ferrous material, a decrease from 1020 kg/tss to 930 kg/tss was observed. The total flux material usage decreased from 220 kg/tss to 130 kg/tss. This reduction leads to a decrease in heat losses and coke consumption due to using less flux material in sinter blend.

The increase in the basicity would also increase the amount of sulfur left in sinter. When the basicity was increased, the extent of binding the sulfur with basic oxides like CaO as CaS would be more possible. BOF slag was a slag itself, so when added to the sinter blend during sintering it would not take place in the slag forming reactions. This would lead to burning the sulfur from the iron ore and coke breeze freely. Thus, increasing the basicity with BOF slag addition would decrease the remained sulfur in the sinter.

The amount of calcium ferrite of sinter samples were also increased with BOF slag addition which filled the matrix of the sinter. Rather than the weakening glassy phase, the network of dendritic calcium ferrites might also help to strength the sinter structures. The decrease in the reducibility of sinter with increasing slag addition probably is related to the mineralogical structures. Reducibility is mostly affected by the Fe²⁺ and Fe₃SiO₄ (fayalite) formations however no sign of fayalite was observed in XRD patterns and mineralogical investigations. This situation was expected as the sinter samples and other condition in sinter making were basic and that favors the formation of dicalcium silicate (Ca₂SiO₄) and ferromonticellite (Ca₆SiO₁₆) rather than fayalite. The more homogeneous the sinter, the stronger it will be.

The use of enriched BOF slag reduced the duration heat necessary to calcine the carbonates and form the slag. As a result, the efficiency and speed of sintering machine would
increase in case of using enriched BOF slag in the sinter blend. The coke consumption and the maximum temperature in the sintering zone would be reduced as well. The amounts of ferrous material and flux material would also be reduced affecting the production cost. The addition of BOF slag into the sinter blend clearly makes it possible to produce high quality sinter at low temperatures with low coke breeze consumption.

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