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High Calcium MSWI Fly Ash's Mineralization Behaviour and Strengthening Technology throughout the Sintering Co-Treatment Procedure

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Abstract

Co-processing of MSWI-FA (fly ash from municipal solid waste incineration) during the sintering of iron ore is a potentially viable option for safe and creative use. In this research, high temperature in-situ, diffusion couple, and sintering experiments were used to study the mineralization behaviour of high calcium water-washed municipal solid waste incinerator fly ash (WM-FA) during iron ore sintering, and the related regulation method was proposed. The tumbler index of sinter was slightly lowered from 69.20% to 68.82% when 1.0 wt% WM-FA was added. When the fraction of WM-FA was increased to 2.0 weight percent, this index fell to 62.43%. Possible explanation for why WM-FA exhibited higher Its lack of mineralization properties were caused by its soft melting temperature, which was lower than the sintering mixture's [1-5]. The mineralization process both within and outside of WM-FA was greatly improved by the addition of 20 weight percent iron ore, and a significant volume of CaO•Fe2O3 liquid phase was produced. Sinter's tumbler index rose from 62.43% to 68.35%. The theoretical underpinnings for the treatment of fly ash from municipal solid waste incineration in the sintering process are provided by research findings, which have major implications for the development of the iron and steel industry as well as urban sustainability. Municipal solid waste incineration has increasingly grown in importance as a method of waste treatment thanks to advancements in waste burning technology and evaluation standards. Fly ash, which makes about 3–5–% of the waste incineration quality, will be created throughout the trash incineration process. The fly ash has been classified as hazardous waste in the majority of nations because it contains numerous dangerous compounds, including heavy metals, dioxins, and alkali. Therefore, governments all over the world are concentrating their study on ways to recycle the municipal solid waste incineration fly ash.

Introduction

For MSWI-FA, there are typically three different treatment options I solidification/stabilization separation and extraction and heat treatment MSWI-FA is currently mostly treated through stabilisation and solidification. However, this treatment approach uses up a lot of available land .The dioxin has not been adequately handled despite the lengthy separation and extraction process. In addition to being handled as a waste in a safe manner, MSWI-FA can also be used as a resource. Ways [6-7]. A small bit of fly ash can be used to change the substance. The usage of MSWI-FA as a raw material in the manufacture of construction aggregate has also been researched recently Thermal treatment can modify MSWI-FA by destroying hazardous chemical substances like PCDD/Fs (Polychlorinated dibenzo-p-dioxins and furans) and producing a more stable crystal structureto support detoxification and establish the groundwork for increased resource use. Melting vitrification thermal plasma technology [16], and melting vitrification are the three primary types of thermal treatment technology and (iii) co-treatment in a steel furnace and cement kiln. The method of separate heat treatment is constrained by the high investment and energy consumption. The co-treatment of MSWI-FA by furnace is currently a hot topic in study. The iron and steel smelting process, in example, uses a variety of high-temperature furnaces and offers a lot of potential for co-treating fly ash. There is, however, a dearth of study on the effects of fly ash's inherent components on the thermal treatment process, with the majority of earlier studies concentrating on the effects of additives and water washing pretreatment on MSWI-FA.

The first high-temperature procedure in the iron and steel sector is iron ore sintering. China now produces more than one billion tonnes of sinter annually. The following benefits are mostly associated with the iron ore sintering method used to treat waste incinerator fly ash. The typical high-temperature sintering process is conducive to the decomposition of dioxins and has a complete flue gas purification system, which can deal with complex and diverse flue gas pollutants. I Waste incineration fly ash contains a significant amount of CaO, which can be used as calcium based flux in the sintering process partially replacing the flux such as limestone or dolomite required in the sintering process.

Subjective Heading

An iron and steel company in the country provided the iron ore, flux, and fuel that were used in the sintering test. Iron ore was one of them, along with mixed iron ore and return ore [8-15]. Quicklime, dolomite, and limestone were all part of the flux. As may be seen in the fuel used was coke powder. The data clearly shows that Fe2O3, which has a percentage of SiO2 of 4.47 weight percent and a trace amount of CaO, is the primary constituent of mixed iron ore. CaO makes up the majority of the three fluxes. Quicklime has the largest CaO content, at 80.63 weight percent, while dolomite has the lowest, at 30.16 weight percent. Quicklime had a significantly greater SiO2 content than

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the other two fluxes. The MSWI-FA used in this investigation came from a domestic municipal solid waste incineration facility that had a processing capability of 5 104 tonnes of trash per year and was fitted with three reciprocating mechanical moving grates that produced between 1.5 and 2.5 104 tonnes of garbage annually. In order to remove the chloride salt from MSWI-FA and lower the amount of chlorine in WM-FA to less than 1.0 weight percent, WM-FA was obtained by three stages of countercurrent water washing of MSWI-FA.

Chemical analysis, atomic absorption spectrometry (AAS) and inductively coupled plasma mass spectrometry (ICP-MS) were used to analyze the chemical composition of the raw fly ash and WM-FA. The main chemical components were shown. It can be seen that the removal effect of Cl in the washing process was significant, and the removal rate reached 94.90%. In addition, the elution rates of K_2O and Na_2O were 89.61% and 55.32%, respectively, indicating that water washing can also remove K and Na. The content of CaO in WM-FA was higher than 40 wt.%, which was mainly from the unreacted $Ca(OH)_2$ in the treated.

Discussion

The laboratory sintering cup was utilised for the sintering test on the sintering mixture that passed the aforementioned examination depicted the test apparatus. The sintering cup had a 180 mm diameter, and the sintering mixture was 900 mm tall. It was prepared for ignition once the sintering mixture had been evenly spread. The ignition duration was 2 minutes, the insulation time was 2 minutes, and the ignition negative pressure was 7 kPa. The ignition temperature was 1100 10 °C. For air extraction sintering after ignition, adjust the negative pressure to 14 kPa. Following sintering, the tumbler index was assessed, and significant indices including yield, productivity, and sintering speed were calculated. The mechanical strength of sinter, which is tested in accordance with ISO3271 (2007), is measured by the tumbler index. The productivity is an index to measure the sintering production capacity and refers to the ratio of sinter quality to sintering time and cross-sectional area of sintering cup, t•m2•h1. Yield is the percentage of sinter particle size greater than 5 mm. Sintering speed is the ratio of material layer height to time, mm•min. SEM/EDS was used to observe and study the completed sinter's structure and content.

Since the majority of the chlorine salt in the WM-FA is removed during the water washing pretreatment, there was no evident volatilization of the WM-FA during the high temperature procedure. Additionally, the main body of the WM-FA essentially melts at temperatures above 1300 °C and forms a significant volume of liquid phase. Since the maximum temperature during sintering was close to 1300 °C, the WM-FA can thus take part in mineralization and efficiently solidify. At around 1150 °C, the WM-FA and sintering mixture started to melt. At roughly 1330 °C, a strong reaction took place. When WM-FA was added to the sintering mixture in the form of pellets, the mineralization reaction could not fully take place at the sintering site if the addition amount exceeded a specific proportion.

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Diffusion temperatures for WM-FA and sintered mixed pellets were 700, 1000, 1200, and 1300 °C, respectively. After the reaction, the morphology of the WM-FA cross section was examined where I was the contact surface between WM-FA pellets and mixture pellets. The outcomes were displayed according to the figure, the diffusion behaviour of WM-FA and the sintering mixture had not greatly changed at 700 °C because there was only a small amount of mixture on the surface of the contact surface. The mixture reacted with the WM-FA and penetrating at 1000 °C entering the WM-FA 407 m was the narrowest penetration width. The largest area measured 773 m. The sintering mixture penetrates into the WM-FA pellets at a high temperature during the 1200 °C calcination process, and the WM-FA pellets react with the sintering mixture pellets to produce a significant volume of liquid phase. At 1300 °C, there was total penetration between the WM-FA and the mixture, an even distribution of the liquid phase, and no WM-FA accumulation in lumps.

Conclusion

WM-FA iron distribution was subjected to an EDS examination, as depicted. The figure shows that the CaO•Fe2O3 and 2CaO•Fe2O3 produced by the solid-phase reaction were significantly increased when compared to the WM-FA without iron, while CaSiO4 was decreased and more liquid phases were distributed around the CaO that was not involved in the ore-forming reaction, which contributed in some way to the fixation of harmful elements in the WM-FA. The impact of adding various amounts of WM-FA on sintering performance was discovered: raising the amount of WM-FA to 1.0 weight percent slightly decreased the tumbler index, which appeared to be a decrease while increasing the Due to its higher soft melting temperature than the sintering mixture, the WM-FA in the pellets may not have been involved in mineralization in the proportion of 2.0 wt%.

The diffusion couple test demonstrated that the 20 weight percent iron ore addition to the WM-FA pellets was beneficial to the internal mineralization reaction and may alter the diffusion response behaviour of the external sinter to the WM-FA pellets. The sintering test revealed that it was simple to add WM-FA pellets to iron during the sintering process, which encouraged the mineralization of WM-FA and the creation of liquid phases.

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Conflict of Interest

The authors declare that there are no conflicts of interest.

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