METALLURGY AND MATERIALS SCIENCE

DOI - 10.32743/UniTech.2021.92.11.12560

TECHNOLOGY OF INTEGRATED PROCESSING OF STEEL-MELTING DUSTS

Begzod Karimjonov
Senior teacher Department of Metallurgy, Tashkent State Technical University, Republic of Uzbekistan, Tashkent
E-mail: hojiyevshohruh@yandex.ru

Sohibjon Matkarimov
Associate Professor of the Department of Metallurgy, Tashkent State Technical University, Republic of Uzbekistan, Tashkent

Oybek Nuraliev
Assistant of the Department of Metallurgy, Tashkent State Technical University, Republic of Uzbekistan, Tashkent

Qahramon Ochilideev
Senior teacher Department of Metallurgy, Tashkent State Technical University, Republic of Uzbekistan, Tashkent

Nasiba Yuldasheva
Master student of the Department of Metallurgy, Tashkent State Technical University, Republic of Uzbekistan, Tashkent

ТЕХНОЛОГИЯ КОМПЛЕКСНОЙ ПЕРЕРАБОТКИ ПЫЛЕЙ СТАЛЕПЛАВИЛЬНОГО ПРОИЗВОДСТВА

Каримжонов Бегзод Рахматжонович
ст. преподаватель кафедры «Металлургия», Ташкентский Государственный Технический Университет, Республика Узбекистан, г. Ташкент

Маткаримов Сохибжон Турдальевич
доц. кафедры «Металлургия», Ташкентский Государственный Технический Университет, Республика Узбекистан, г. Ташкент

Нуралиев Ойбек Улуғбекович
ассистент кафедры «Металлургия», Ташкентский Государственный Технический Университет, Республика Узбекистан, г. Ташкент

Очилдеев Кахрамон Тоштемирович
ст. преподаватель кафедры «Металлургия», Ташкентский Государственный Технический Университет, Республика Узбекистан, г. Ташкент

Юлдашева Насиба Сайдахматовна
магистрант кафедры «Металлургия», Ташкентский Государственный Технический Университет, Республика Узбекистан, г. Ташкент

Библиографическое описание: TECHNOLOGY OF INTEGRATED PROCESSING OF STEEL-MELTING DUSTS // Universum: технические науки : электрон. научн. журн. Karimjonov B.R. [и др.]. 2021. 11(92). URL: https://7universum.com/ru/tech/archive/item/12560
The processing of dust from steel-making furnaces requires special attention, since, firstly, it is impossible to simply use them as an additive to the charge (this will worsen the quality of steel); secondly, it is not subject to burial in the ground, since soil poisoning is possible; thirdly, it is advisable to extract valuable components (except for iron) contained in such dust from such dust.

Keywords: steel furnace dust, collection, petroleum coke, sintering.

### Table 1.

| Compounds | Content, % |
|-----------|------------|
| Fe_{total} | 31.2       |
| Fe_{2}O_{3} | 41.6        |
| FeO         | 4.6         |
| P_{2}O_{5}   | 0.2         |
| SO_{3}       | 0.9         |
| SiO_{2}      | 3.4         |
| ZnO         | 16.2        |
| PbO         | 1.36        |
| CuO         | 0.36        |
| Cr           | 2.4         |
| CaO         | 3.4         |
| Al_{2}O_{3}  | 0.9         |
| MnO         | 3.7         |
| MgO         | -           |
| Cr_{2}O_{3}  | 0.6         |
| NiO         | 0.03        |
| TiO_{2}      | 0.14        |
| Na_{2}O      | 10.4        |
Petroleum coke of the Fergana Oil Refinery (FOR) was chosen as reducing agents for zinc oxide and iron oxides contained in steel-making dust [7].

Petroleum coke is a complex dispersed system in which the dispersed phase consists of crystalline formations (crystallites) of different sizes and ordering in the mutual arrangement of molecules and pores, and the dispersion medium is a continuous gaseous or liquid phase that fills the pores of crystallites, from which adsorption-solvation layers are formed, or solvate complexes. Despite the unequal preparation conditions, the crystallites have similar sizes and are packets of parallel layers (planes). Crystallite sizes (in nm): plane length \( a = 2.4 - 3.3 \), packet thickness \( c = 1.5 - 2.0 \), interplanar distance \( 0.345 - 0.347 \) [8].

**Results and its discussion.** To determine the optimal reductant and its consumption, experiments were carried out using petroleum coke from the Fergana Oil Refinery (FOR) and brown coal from the Angren open pit as reductants.

Based on the industrial experience of the process of Waelz zinc cakes and information obtained from the analysis of literature sources, it was decided to take the amount of coke from the FOR loaded into the charge equal to 40% of the dust mass (average carbon content in the coke is 95%).

When brown coal from the Angren open pit was used as a reducing agent, a lower carbon content in it (73.44%) was taken into account compared to coke, based on this, the amount of coal added to the charge was increased to 52% of the dust mass (95: 73.44 * 40 = 52). The weighed amount of dust for the preparation of the charge with petroleum coke was 20 g, and the amount of added coke was 8 g. The weighed amount of dust for the preparation of the charge with brown coal was also 20 g, and the amount of added coal was 10.4 g.

The prepared charge was loaded into a fireclay crucible and installed in a shaft furnace preheated to 1200 °C and fired for 90 minutes. After a specified time, the crucibles with weighed portions were removed from the furnace and cooled to room temperature.

The residual content of zinc in the clinker and the degree of reduction of iron oxides were carried out on an atomic absorption analyzer in the laboratory "Physicochemical research methods" of the State Enterprise "Institute of Mineral Resources". The results of the analyzes are shown in table 2.

**Table 2.**

| №  | Sample name                                  | Average Zn content, % |
|----|---------------------------------------------|-----------------------|
| 1  | Initial sample of dust                      | 16.78                 |
| 2  | Clinker (charge: dust 20 g + petroleum coke 8 g) | 14.5                |
| 3  | Clinker (charge: dust 20 g + coal 10.4 g)    | 13.4                  |

From the data given in the table it can be seen that when using coal as a reductant, the zinc content in clinker is lower than when using petroleum coke. Based on the results obtained, as well as taking into account the cost of petroleum coke (about 2.4 million soums per ton), which exceeds the cost of coal (about 0.5 million soums per ton) and the high sulfur content in coke, which is a harmful impurity for steel, it was accepted solution to use Angren brown coal as a reducing agent.

The results of the experiment show that the zinc content in the clinker remains high, this can be explained by many reasons, the main of which is the lack of reducing agent and insufficient firing temperature.

To determine the optimal amount of the reducing agent, it was decided to increase the consumption of the reducing agent (coal). Three samples were prepared with a coal content of 65, 80 and 90% of the dust mass in the charge. All three samples were fired under the same conditions (1200 °C, 90 min). The firing results are shown in Table 3 and Fig. 1.

**Table 3.**

| №  | The amount of reducing agent in the charge in% of the mass of dust | Residual zinc content in clinker, % |
|----|------------------------------------------------------------------|----------------------------------|
| 1  | 52                                                               | 13.4                             |
| 2  | 65                                                               | 10.56                            |
| 4  | 80                                                               | 7.98                             |
| 5  | 90                                                               | 7.98                             |
From the research results given in Table 3 and Figure 1, it can be seen that with an increase in the amount of coal in the charge to 80-90% of the dust mass, the zinc content in the clinker decreased to 7.98%. The extraction of zinc in sublimates is 52.4% (16.78 - 7.98): 16.78 = 52.4).

The choice of the optimal temperature 1200 °C is explained by the fact that at this temperature the degree of zinc sublimation according to the reaction ZnO + Fe = FeO + Zn (g) has large values (Table 4.).

**Table 4.**

| Temperature, °C | Zinc vapor pressure, barr |
|-----------------|---------------------------|
| 1000            | 85                        |
| 1100            | 363                       |
| 1200            | 1260                      |

Based on the data given in the table, it can be concluded that a further increase in temperature will favorably affect the stripping of zinc, however, the limitation of the temperature regime is caused by the presence of low-melting components, which, when reflowed, cover the pores of solid particles, causing an obstacle to the stripping of zinc into the gas phase.

Iron present in steelmaking dust during the reduction roasting process is also reduced from oxide compounds to metal. The reduction of iron oxides with carbon is described by the reactions:

\[
\begin{align*}
3\text{Fe}_2\text{O}_3 + \text{C} & = 2\text{Fe}_3\text{O}_4 + \text{CO} \\
\text{Fe}_3\text{O}_4 + \text{C} & = 3\text{FeO} + \text{CO} \\
\text{FeO} + \text{C} & = \text{Fe} + \text{CO}
\end{align*}
\]

The resulting metallic iron during the reduction firing of steel-making dusts will increase the extraction of zinc into sublimates; it will restore zinc from oxides by the reaction:

\[
\text{ZnO} + \text{Fe} = \text{Zn} + \text{FeO}
\]

In addition, due to the carburization of iron at a temperature of 1150 °C, cast iron will be formed. As a result of reductive roasting, the zinc content in the dust will decrease due to the distillation of zinc into the gas phase and a solid product, the so-called "clinker", is obtained, in which the bulk of the iron will be in metal form, which will allow it to be remelted in steel-making furnaces without preliminary preparation.

The results on the reduction of iron oxide when carrying out a reductive roasting with coal as a reducing agent are shown in Table 5.

**Table 5.**

| №  | Sample name             | Fe, %  | FeO, % |
|----|-------------------------|--------|--------|
| 1  | Initial steelmaking dust| 31,3   | 2,54   |
| 2  | Clinker after reduction firing | 31,8-34 | < 0,02 |
Atomic absorption analysis determined the content of zinc in the sublimates. The zinc content in sublimates is 64.41%.

Conclusion. The problem of involving dust in the steelmaking industry is especially acute at the present time, when the enterprises of the ferrous metallurgy of the Republic are experiencing a shortage of raw materials. At present, the warehouses of Uzmetkombinat JSC have accumulated 60 thousand tons and annually generate 10 thousand tons of steel-making dusts with a ZnO content of up to 17%.

One of the solutions to this problem may be to reduce the amount of zinc charged into the steelmaking furnace along with the raw materials. The studies carried out have established that the stripping of zinc and the reduction of iron oxides, possibly by means of reductive roasting. The use of brown coal from the Angren deposit is proposed as a reducing agent.

For the practical implementation of the proposed technology, it is proposed to use the existing technology and hardware design of the Waelz zinc cakes used at the zinc plant of the Almalyk Mining and Metallurgical Combine.

References:
1. Хожиев Ш.Т., Эркинов А.А., Абжалаов Х.Т., Мирсаотов С.У., Мамараимов С.С. Использование металлургических техногенных отходов в качестве сырье // “Студенческий вестник”: научный журнал, № 43(93). Часть 5. Москва, Изд. «Интернаука», Ноябрь 2019. С. 69 – 71.
2. Юсупходжаев А.А., Хожиев Ш.Т., Мирзажонова С.Б. Анализ состояния системы в металлургии. Монография. – Beau Bassin (Mauritius): LAP LAMBERT Academic Publishing, 2020. P. 189.
3. Каримжона Б.Р., Бердяев Б.Т., Маткаримов С.Т., Хожиев Ш.Т. Анализ современного состояния переработки цинкодержащих сталеплавильных пылей // “Zamonaviy kimyoning dolzarb muammolari” mavzusidagi Respublika miqyosidagi xorijiy olimlar ishtirokidagi onlayn ilmiy-amaliy anjumani to’plami, Buxoro, 4-5 dekabr, 2020. 65 – 66 b.
4. Khojiev Shokhrux, Berdiyarov Bakhridinn, Mursaatov Suxrob. Reduction of Copper and Iron Oxide Mixture with Local Reducing Gases. Acta of Turin Polytechnic University in Tashkent, 2020, Vol.10, Iss.4. P. 7-17.
5. Alamova G.Kh., Jo’raev Sh.Sh., Rakhimov N.S., Khojiev Sh.T. Kinetics of Carbon-Thermal Reduction of Magnetite. Студенческий вестник: электрон. научн. журн., Часть 3, 2021, 8(153). С. 60-62.
6. Alamova G.Kh., Rakhimov N.S., Jo’raev Sh.Sh., Khojiev Sh.T. Reduction of Volatile Metal Oxides. Студенческий вестник: электрон. научн. журн., Часть 3, 2021, 8(153). С. 69-71.
7. Khojieev S.T., Nuraliev O.U., Berdiyarov B.T., Matkarimov S.T., Akramov O’A. Some thermodynamic aspects of the reduction of magnetite in the presence of carbon // Universum: технические науки: электрон. научн. журн., Часть 3, 3(84), 2021. Р. 60-64. DOI - 10.32743/UniTech.2021.84.3-4.
8. A.A. Юсупходжаев, Ш.Т. Хожиев, У.А. Акрамов. Использование нетрадиционных восстановителей для расширения ресурсной базы ОАО «Узметкомбинат» // Черные металлы, апрель 2021, № 4 (1072). С. 4 – 8. DOI: 10.17580/chm.2021.04.01.