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Returning Electrostatic Precipitators to the Fe-Ni Production Process

Vrnitev elektrostatičnih filtrov v proizvodni proces Fe-Ni

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Abstract in English

The process of frying the Fe-Ni charge in rotary kilns inherently produces large amounts of process dust, which rotary kilns clean out through the use of electrostatic precipitators [1].

One kiln contains two sections of electrostatic precipitators as a safety mechanism [1]. Electrodes installed in the sections produce electric fields when electricity passes through them, and ionize the dust.

The timing of the process must be coordinated carefully, and these electrodes are struck with hammers and occasionally shaken, generating quantities of dust which are then collected in a snail dust conveyor, then returned to the production process and recycled. In addition, a smaller amount of dust is derived from the gas chamber, which returns to production without entering the cleaning process in the electro filters. The difference between the two types of dust is their granulation size [1].

We conducted the research during the years from 2017 through 2020, calculating the components of the rotary kiln process. Here, we present a linear equation as a result of the ratio of calcine and electrofilter dust.

Keywords: dust, calcine, electro filter, adhesion, rotary kiln

Abstract in Povzetek

Proces žganja Fe-Ni vložka v rotacijskih pečeh proizvede velike količine procesnega prahu, ki ga rotacijske peči očistijo z uporabo elektrostatičnih filtrov [1].

Ena peč vsebuje dve vrsti elektrostatičnih filtrov kot varnostni mehanizem [1]. V odseku kjer so nameščene elektrode se ob prehodu elektrike ustvarjajo električna polja in prah ionizira.

Pravi čas je skrbno usklajen. S pomočjo kladiv, ki te elektrode udarjajo in občasno stresajo, nastanejo znatne količine prahu. Te se nato zberejo v polžjem transporterju za prah, ki se nato reciklira in vrne v proizvodni proces. Poleg tega se iz plinske komore pridobi manjša količina prahu, ki se vrne v proces brez vstopa v proces čiščenja v elektrofiltrih, pri čemer je razlika med obema vrstama prahu v granulaciji [1].

Raziskavo smo izvedli v letih 2017–2020, pri čemer smo izračunali komponente procesa rotacijske peči in predstavili linearno enačbo kot rezultat razmerja žganega in elektrofiltrskega prahu.

Ključnebesede: prah, žganje, elektrofilter, adhezija, rotacijska peč

Introduction

The ferronickel plant in Drenas uses ores that contain a high percentage of moisture, in which the average humidity over the years reaches about 30% [2]. This amount of ore is not subject to drying before the frying process; therefore, the amount of fuel that makes up the charge is high, leading to a large amount of dust and process gasses.

Ores used in the ferronickel plant are the following:

- Ores from Kosovo (mines of Çikatove and Gllavice)
- Ores from Albania
- Ores from Guatemala

The rotary kiln compartment consists of two kilns, both 100 m in lengthand 4 m in; the angle of inclination with respect to the horizontal is 20 degrees [1]. The capacity of the wet charge per day is 2400 tons (t). Moreover, until the end of 2019, the refractory material was chamotte; beginning from the end of 2019, however, the refractory material has been anchored concrete.

The process occurs in the following three zones:

- Drying zone
- Heating zone
- Frying zone

Nickel oxide ores make up significant amounts of fine fractions. During the frying of ore with exhaust gases, a range of up to 8–12% of the Fe-Ni ore is subjected to metallurgical processing.

The return of dust, that is, the ore that passes to cleaning in the processing system is an additional requirement of the dust-cleaning system [1]. In order to clean the dust from the gases of the rotary kilns, the following structures are used: a chamber for charging the rotary kiln, the carrier structure of the dust chamber, and the electronic filter.

The ring for filling the rotary kiln is made in such a way that even large changes in the trajectory of movement of gases are taken into account. In this case, the large fractions fall into the chambers to fill the rotary kiln, where they accumulate together with the charge poured. The gas flowing through the conductor system encounters the the electrical field forming the filter. Two sections of electronic filters of type 2PAA-4040-90100-1 are placed in every kiln [1].

The electronic filters have four dust collectors, 14 control holes, and one filter section has 1485 and the other 10,500 cleaning electrodes, both sets of electrods being 2-mm in thickness. The gas is purified at a rate of 7300 m^3n/min at a temperature of 375°C, and the gas is dusted at a rate of 50 g/m^3n. This process results in a gas purification level of 99% [1].

FLS MT 315 S fans are used to suck the gases from the rotary kilns. The first kiln contains two fans, and the second kiln contains four fans. In the collectors of rotary kilns, the frying process provides a system for the return of dust from electric filters and chambers. In the dust chambers, conveyors 7 and 7a, 8 and 8a and coils 1 and 1a, 2 and 2a place the dust in an elevator. A portion of the spill from conveyors 7-7a and 8-8a is recovered and also placed in the elevator [1].

The transport capacity and conditions consist of the following: 10 t/h, 300-mm diameter, up to 250°C temperature, 6- to 25-mm length, and an electric motor power of 2.2–5.5 kW. The yield of dust on the side of the evaporator increased to +25.7 m from a previous yield of +1.32 and +2.29 m [1].

In the receiving collectors of the rotary kilns, two elevators are placed for the purpose of returning dust to the rotary kilns N-1 and N-2. By means of the ninth conveyor, it is possible for the dust, which is attached to the gas-cleaning system of the rotary kiln N-1, to be thrown into the elevator, which delivers the dust captured by the gas-cleaning system of the N-2 rotary kiln. From the elevators, the dust is poured into conveyors 10 and 10a, which are poured through conveyors 11-11a into the equipment for filling the rotary kiln. The filling device enables the transfer of the dust inside the oven along with the dust in the charge. This operation reduces the circulation of dust.

If the furnace breaks down, it creates and collapses the rings glued to its inner walls, which contributes to the increase in the size of the pieces of ore. As a result, the ore cannot pass through the sieve placed at the bottom of the furnace. The enlarged pieces of ore are transported to the special base and from there the loading equipment loads the ore into trucks, which return it to the processing department.

Methodology

Our methods for this study were based on the industrial working processes of rotary kilns during the four years analysed (2017–2020).

Figure 1 shows the industrial data for the charge composition for rotary kilns, which comprises the product of the rotary kiln (calcine), moisture composition, adhesion composition, and dust composition calculated as percentages of total content [2].

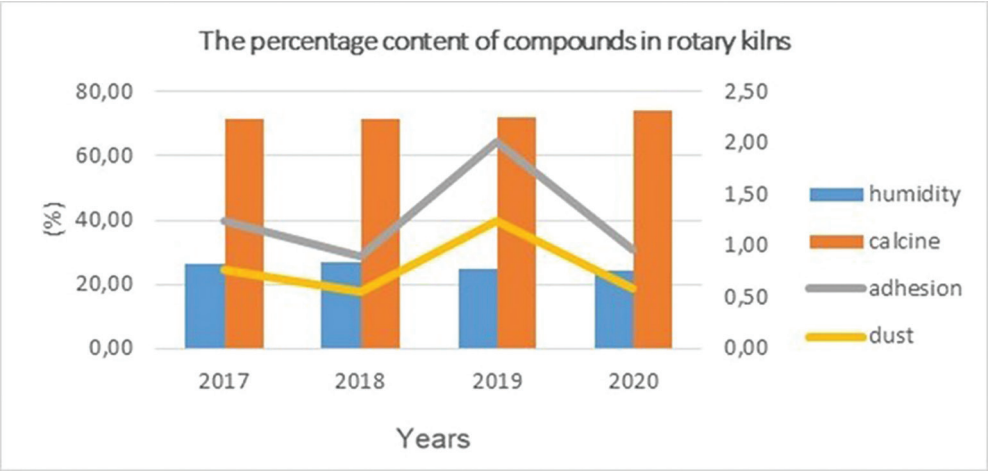


Figure 1: *Graphical representation of the amount of ores, moisture, calcine, adhesion, and dust in the product of rotary kilns.*

The return of the electrofilter dust into the production process benefits the environment.

Discussion of results

The dust has the same composition as the calcine produced in rotary kilns. Therefore, its return to the process has economic and environmental benefits, the main purpose being the reduction of nickel losses to a minimum.

The graphic representation (Figure 1) shows that the amount of calcine and the composition of the ore moisture as products of charge reached adhesions of 1% in 2018, 2% in 2019, and 1% in 2020 of the calcine produced [3].

Moreover, calculations of the moisture content of the ore the amount of calcine produced, and the adhesives (Figure 1), allowed us to calculate the amount of dust created during the years analysed. In 2017, the amount of dust was 0.77% of the amount of calcine produced. In 2018, the amount of dust came to 0.55% of the amount of calcine produced, and the amount of adhesives reached 1.25% of the amount of calcine produced. In 2020, however, the amount of dust scored 0.59% that of calcine produced [3].

Figure 1 shows that during the year 2019 the amount of dust produced as a result of processing Guatemalan ore was high. Guatemalan ore contains large amounts of moisture, which in turn leads to the creation of more dust [1]. Figure 2, however, shows the amount of Fe-Ni ore spent during the years 2017–2020, where it is worth noticing the significant drop in production in 2018 due to a halt in use of the rotary kilns.

From analysing industrial practice, we have reached the conclusion that 1800 kg of dust is formed in one hour from 80 t/h of pure charge.

Dust comes as a consequence of:

- Equipment overload
- Amortization of snails
- The low capacity (12 t/h) of snails
- The large amounts of dust generated from processing ores from Guatemala and Albania

We obtained the linear equation presented in Figure 3 from the ratio of calcine to dust generated from using the electrofilter process of rotary kilns.

As a result of all the factors in our analysis, we can conclude that the amount of dust increases as the moisture content contained by Fe-Ni ore increases [4].

Because the composition of the dust is the same as the composition of the calcine produced in rotary kilns, returning to the use of electrostatic precipitators should be a well-accepted process. because they result in improved recovery of valuable components of the process. Moreover, the use of electrostatic precipitators is favourable from an environmental point of view.

If the electrofilter dust were to be released into the atmosphere, it would have a

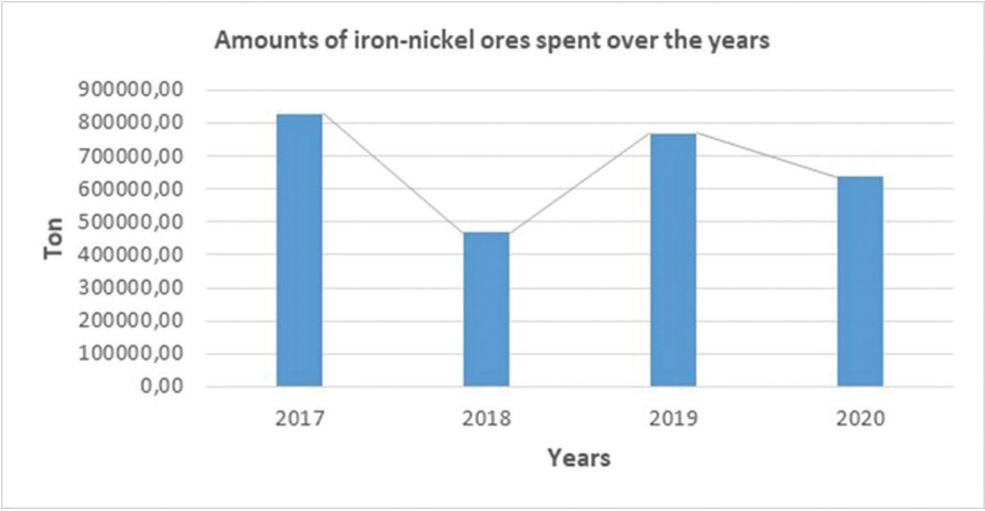


Figure 2: *Graphical representation of the amount of Fe-Ni ore used during the years 2017–2020.*

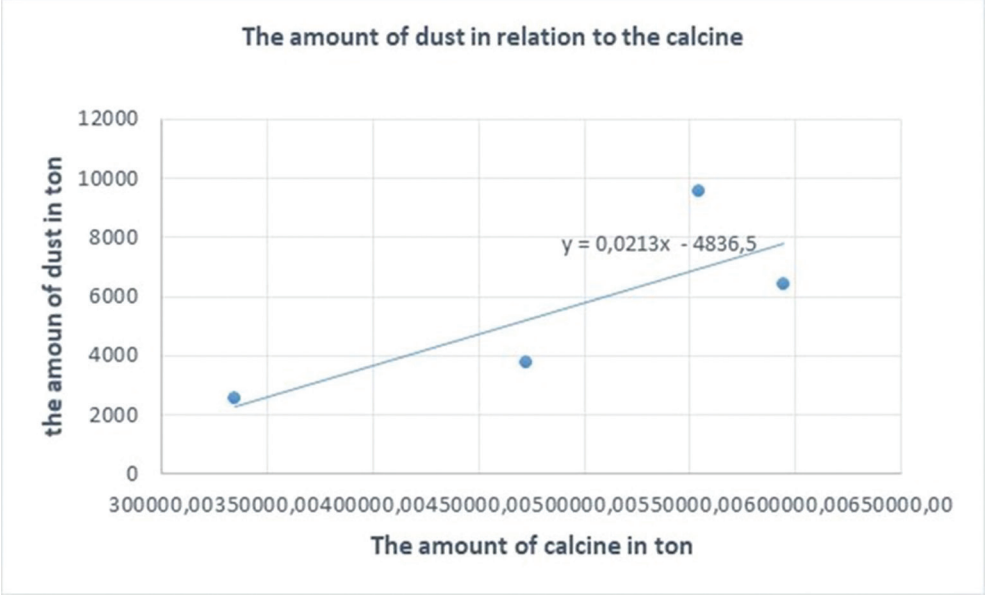


Figure 3: *The representation of the amount of dust in relation to calcine.*

negative impact on the environment, particularly people and plants, as well as animals that graze around the Ferronikeli plant, thereby making a harmful impact on all chains of life.

Recommendations:

- Installation of two dryers at the Ferronikeli plant for drying of Fe-Ni ore
- Granulation of Fe-Ni ore
- Use of a greater amount of Kosovo's dry lignite

References

[1] Bajraktari Gashi, Z. (2012): *Theoretical and experimental research in order to reach optimum technical, technological and productive parameters during qualitative reduction of Ni ore in Fe-Ni Plant in Drenas*. Ph.D. Thesis. University of Prishtina "Hasan Prishtina", Faculty of Geoscience of Technology in Mitrovica, Department of Materials and Metallurgy: Kosovo, 108 pp.

[2] Bajraktari-Gashi, Z., Halilaj, B. (2018): Material balance of the technological process in the New

Foundry of New Ferronikel in Drenas during 2017. *Journal of Technology and Exploitation in Mechanical Engineering*, 4(1), pp. 29–35, DOI:10.35784/jteme.90.

[3] New Ferronickel Complex L.L.C. (2017–2020). Official Documentation of Melting.

[4] Bajraktari Gashi, Z., Zabeli, M., Halilaj, B. (2018): The impact of pet-kok in the technological process of production of Fe-Ni in the new foundry of the new Ferronickel in Drenas. *Journal of International Environmental Application and Science*, 13(1), pp. 72–77.