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Key Metallurgical Parameters of Fe-Ni Production During 1984–1997 and 2007–2017 at the Ferronickel Smelter in Drenas

Ključni metalurški parametri proizvodnje Fe-Ni med letoma 1984 in 1997 ter 2007 in 2017 v topilnici feroniklja v Drenasu

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Abstract

During 1984–1997, the ferronickel plant in Drenas used iron-nickel ore from the mines of the Republic of Kosovo: Glavica and Çikatove (Dushkaje and Suke) mines. However, during the years 2007–2017, when the plant started operating from the cessation of production, which was from 1998 to 2007, some types of iron-nickel ores from different countries began to be used, starting from iron-nickel ores from Kosovo, iron-nickel ores from Albania, ores from Indonesia, ores from the Philippines, ores from Guatemala, ores from Turkey and ores from Macedonia. The ore composition, however, is mainly oxide-laterite ore. Iron-nickel ores in the plant are characterised by high moisture content, a very important factor influencing the process of scraping the charge in rotary kilns and presenting in general. Among the iron-nickel ore used in the ferronickel plant, the ores from Albania are characterised due to their low moisture content when compared with the other ores as well as the high content of iron oxides, which affect the temperature rise inside the furnaces, as the iron ores play an important role in the pre-casting process in rotary kilns.

Key words: calcine, alloys, ore, foundry, Fe-Ni alloy.

Povzetek

Med letoma 1984 in 1997 je topilnica feroniklja v Drenasu uporabljala železo-nikljevo rudo iz rudnikov v Kosovem: rudniki Glavica in Cikatove (Dushkaje in Suke). Med letoma 2007 in 2017, potem ko je po zaprtju v obdobju od 1998 do 2007 proizvodnja ponovno začela obratovati, pa so začeli uporabljati železo-nikljevo rudo iz drugih držav, kot so: železo-nikljeve rude iz Kosova, železo-nikljeve rude iz Albanije, rude iz Filipinov, rude iz Guatemale, rude iz Turčije in rude iz Makedonije. Sestava omenjenih rud temelji na oksidno-lateritni osnovi. Za železo-nikljeve rude je značilna visoka vsebnost vlage, kar je zelo pomemben dejavnik pri procesu plavljenja rude, ki vpliva na splošen potek plavljenja in postopek strganja vložka v rotacijskih pečeh. Med železo-nikljevimi rudami, ki se uporabljajo v topilnici feroniklja, je za rudne iz Albanije značilna nizka vsebnost vlage in velik delež železovih oksidov v primerjavi z drugimi rudami. Velik delež oksidov vpliva na povišanje temperature v rotacijskih pečeh, kjer železove rude igrajo pomembno vlogo tudi pri procesih, ki se vrstijo pred litjem.

Ključne besede: žganje, zlitine, rude, talilnica, Fe-Ni zlitina.

Introduction

The new Foundry of the new Ferronikel in Drenas is located near the source “Old Çikatove” 37 km northwest of Prishtina. The production of metallurgy until now in the Republic of Kosovo is oriented in processing ore of local mines, such as Golesh and Çikatove, and imported ore (from the year 2007) from Indonesia, Philippines, Guatemala, Albania, Macedonia and Turkey.

The processing is done using the electro-reduction process to prepare Fe-Ni as the final product. The fundamental establishments and the equipment of the foundry are two rotary kilns of the firm “Schmid” Copenhagen, two rotary kilns of the firm “Elkem”-Spikerverket, Oslo and two convertors LD of the firm Krupp, Dusseldorf [1].

In the new foundry in the new Ferronickel in Drenas, the process of Fe-Ni production passes through the following stages: processing of Fe-Ni ore and fuels and their delivery to appropriate bunkers where with the aid of conveyor belts they enter the rotary kiln. At a temperature of over 500°C using special equipment, the fuel enters, consisting of heavy-oil and pet - kok, that influence the temperature increase of the rotary kiln (over 700°C) and the qualitative production of calcine [2]. The calcine produced by the rotary kilns is sent to the electric furnace through special pipes where the Fe-Ni metal production process and the quantity of slag are realised.

The produced metal from the electric furnace is sent to the converter for refining, in which an amount of limestone is introduced, and oxygen is blown into it. After the refining, metal is poured into special equipment where we have the production of Fe-Ni metal, in the form of granules of the size of 15–20 mm and weight 5–15 g while the remaining slag in the converter is divided into the metallic part and the non-metallic part, where the metallic part gets back in the process [3].

In the new foundry of the new Ferronickel in Drenas during the realisation in 2007–2017, these Fe-Ni ores were used: ores from Kosovo (mines: Gllavice and Qikatove), ores from Albania, ores from Guatemala, ores from Indonesia, ores from the Philippines, ores from Turkey and ores from Macedonia. The composition of the ores is oxide and silicate. The annual average of Ni content in the Guatemala, Philippines, Indonesia ore is higher (Ni = 2%) compared with the Kosovar ore (Ni = 1.5%) and Albanian ore (0.99%) [3].

Working methods

The industrial data are parameters based on the production process of ferronickel in Drenas, during the years 1987–1997, and the industrial production period of Fe-Ni during the years 2007–2017, directly from the production process of the Fe-Ni alloy [1, 3].

During the industrial processes of the analyzed years, we have determined:

- The average of Fe-Ni ore in rotary kilns,
- The average amount of calcine produced from both rotary kilns (Figure 1),
- Amount of Fe-Ni from the electric furnace,
- The average of Ni in tons.

Discussion of results

The research during the years 1984–1997 is based on the data from the archive of the ferronickel Plant, whereas the research during the years 2007–2017 is based on the laboratory and industrial work of the Fe-Ni alloy production in the Plant.

Figure 1 represents the production data of the iron-nickel, starting from:

- Average of Fe-Ni ore,
- Calcine average,
- Average of Fe-Ni alloy,
- Obtained average of Ni in tons [1–4].

The obtained amount of calcine during the years 2007–2017 is 40% higher than the calcine amount obtained during the years 1984–1997, a difference which comes as a result of a few factors.

During the years 1984–1997, the Plant’s start is accompanied with great difficulties, among them the inability of reaching the high temperatures of 900–1000°C as provided by the Gipronickel project (the Plant project of 1983), which was a big problem because the tempera-

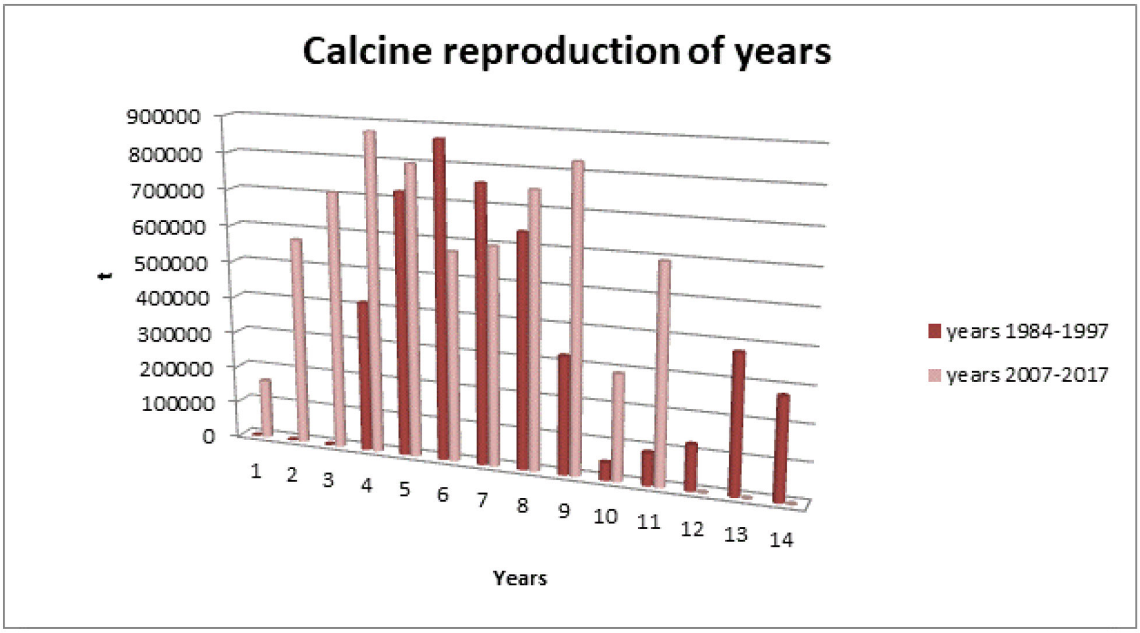

Figure 1: *The produced calcine during the analyzed years.*

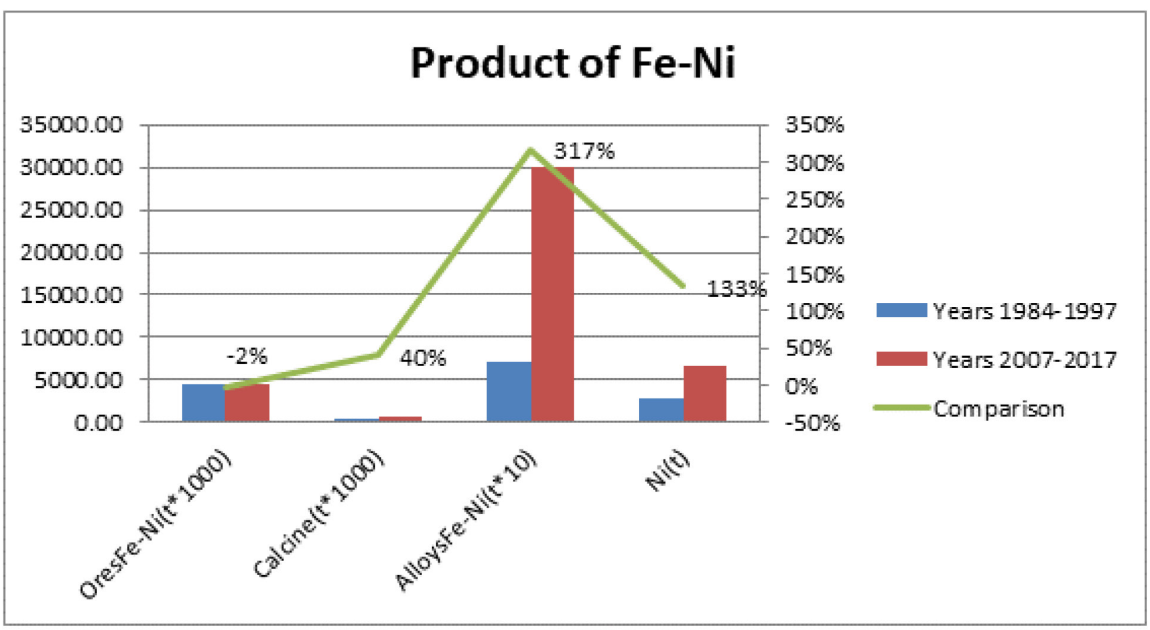

Figure 2: *Graphical representation of Fe-Ni products: the amount of Fe-Ni ore, calcine, Ni in tons and the Fe-Ni alloy as a final product of the process.*

ture plays a crucial role in the process of rotary kilns and the development of pyrometallurgical processes in general [1].

The amount of calcine produced during the years 1984–1997, followed by very high impurity, was frequently interfered within the manufacturing process for the possibility of achieving production parameters as provided by the project (according to the archive and engineering of that time). These were the factors that influenced the low production of both Fe-Ni and Ni quantities in tons, compared with higher production quantities during 2007–2017. During the years 2007–2017, some changes

(a) (b)

Figure 3: *The two forms of Fe-Ni alloy production. (a) The shape of big blocks; (b) The shape of granules.*

were made to the ferronickel plant in Drenas which resulted in the higher production of Fe-Ni alloy:

- Placement of Fe-Ni ore dryer during the years 2010–2012 [4].
- The Albanian ores influenced the reduction of limestone. During the years 1984–1997, the used amount of limestone in the charge was 5%, whereas during the years 2007–2017, it dropped to 2% $CaCO_3$.
- The converter slag and calcine parts returned to the rotary kiln process during 2010 and onwards [5].
- Starting from 2013, there is a change in the production of the physical form of the Fe-Ni alloy.
- Until 2013, the Fe-Ni alloy had the form of big blocks weighing 25 kg, as shown in Figure 3, whereas starting from 2013, the physical form of the Fe-Ni alloy has the shape of a granule around 15–20 mm. The reason behind the change in physical form was the greater possibility of melting for the usage in special steel production [1].

Conclusions

From the analysis of research done during the years 1984–1997 and 2007–2017, we can conclude that as a result of the changes made during the years 2007–2017, we have a higher amount of iron-nickel alloy production [1, 2].

During the laboratory and industrial research of the production parameters analysis 1984–1997 (based on the plant archive) and the years 2007–2017, we may conclude that we analyzed the first 13 years when the ferronickel plant started operating for the first time and the 10 years when the plant started operating again [1, 4].

From the research made, it is clear that the amount of ore input in rotary kilns does not change much, varying only by a 2% increase during the period of 1984–1997; however, the amount of calcine obtained by rotary kilns is 40% higher during the years of 2007–2017, even though the higher ore input of 1984–1997 should have correlated with a higher calcine output [1, 5].

During the research, we have concluded that the low calcine output of the years 1984–1997 is a result of the high impurities which followed the ore and calcine obtained and the frequent cessation of the rotary kilns due to their inability of reaching the adequate temperatures.

From the research we obtain the main parameter of the production of the plant, Fe-Ni alloy is very high during 2007–2017. Changes made during 2007 and 2017 were the major factors in the greater benefits of Fe-Ni alloy production parameters [3].

Recommendations

1. Placement of dryer for iron-nickel ore.
2. The ore with the highest moisture content should be placed inside the dryer.
3. The amount of ore during autumn and winter should be covered in the premises of the Plant.

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Conflicts of Interests

Authors declare that they have no known competing financial interests or personal relation-

ships that could have appeared to influence the work reported in this paper.

Availability of data and material

The research has been conducted thanks to the data of the Ferronickel archive, concerning the data needed from 1984 to 1997, whereas the rest of the research including the parameters for the years 2007–2017, has been conducted at the Ferronikel Foundry in collaboration with Behram Halilaj.

Author's contributions

This research paper has been realised by my work as the main author, as well as the contribution of Muharrem Zabeli and Behram Halilaj as corresponding authors.

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