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Laboratory and Industrial Research in the Rotary Kilns During the Years 2012-2017 in the New Foundry of the New Ferronikel in Drenas

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Abstract: In this study, we have analyzed the laboratory and industrial research during the years 2012-2017. During the analyzed research, we have managed to determine the process phases in the rotary kilns starting from:analysis of ore composition, average of ore humidity, average of Ni percentage in ore, composition of fuel which together with the Fe-Ni ore make up the load for the rotary kilns, fuels which impact the increase in temperature in rotary kilns (heavy oil and pet kok) amount of calcine, temperature of calcine, average of Ni percentage in calcine, calculation of Cfix ton of calcine during the analyzed years, scale of prereduction. The research has been carried out in the Foundry's Laboratory and the process has been realized in the New Foundry of the New Ferronikel in Drenas

Key words: Fuel, Cfix, Fe-Ni ores, cacline, temperature, rotary kilns

INTRODUCTION

The metallurgical process in the new Foundry of the New Ferronikel in Drenas is realized by a variety of ores both imported and local. A few types are used as fuel. The compositions of ores used in the Foundry show different percentage levels of nickel, iron, humidity and other elements. Through the years 2012-2017, oxide ore raw materials have been supplied from: Kosovo (sources Cikatova, Gllavica), Albania, Philippines Indonesia, Turkey and Guatemala. Ore sources in the goethite area in Gllavica are characterized by an increase of SiO_2, the percentage of which decreases as a function of depth. This area is characterized by an increase in iron (20.23%) and a decrease of the percentage of nickel (0.51). According to the mineralogical analysis in the nontronite area, there is an increase of MgO, the percentage of nickel (1.96%) and a decrease in the percentage of iron (13.89%).

The characteristics of ore sources in Gllavica are: high ore humidity (external) high percentage of SiO_2 in comparison to the other ore sources used in the Foundry. Ore sources of the Gllavica (Kosovo) are characterized from the composition of:

- Percentage of nickel 1.5%
- High humidity (w)
- High percentage of iron

Ore sources of the Cikatova (Kosovo) are characterized from the composition of:

- The composition of SiO_2 and FeO decreases whereas that of MgO increases, the percentage of CaO 11.1% in years 2017
- Percentage of nickel 1.10%
- The percentage of SiO_2 is high
- The percentage of iron is lower compared to that of ore sources in Albania
- Ore sources in Indonesia are characterized by the composition: of high humidity (w), of high percentage of MgO

Ore sources of the Philippines are characterized from the composition of:

- High percentage of nickel (1.99% Ni)
- Humidity (w)
- High percentage of iron
- High percentage of MgO

Albania's ore sources are characterized by a few types of ores where the following can be witnessed:

- High percentage of Fe
- Lower percentage of Ni (0.99% Ni)
- Low percentage of humidity

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Guatemala's ores are characterized by:

- High percentage of SiO_2
- High percentage of Ni (2% Ni)
- High percentage of humidity

Of all the ores used, those from Albania's sources are characterized by a higher percentage of iron and a lower percentage of humidity.

Amount of fuels: The amount of fuels is mostly made up of lignite, coal and lately biomass. During the laboratory and industrial research we notice that the amount of coal which has (Cfix = 50%) a small percentage of the amount of ash and humidity, affect the increase of the prereduction scale in the process of rotary kilns. The increase of temperature in the rotary kilns is affected by the amount of fuel, pet kok and heavy oil which are inserted through special equipment over 500°C. Over the past few years it has had a positive impact in the process of rotary kilns (Fig. 1-6).

Fuels which are used during the past years in the rotary kilns have the following composition:

- Russian coal, Cfix = 44.31% ash = 3%, humidity = 18.64
- Indonesian stone coal, Cfix = 55.25%,Ash = 9.02%, humidity = 2.89%
- Kosovar dry lignite, Cfix = 31.28% ash = 20.13%, humidity = 23.4%
- Kosovar wet lignite, Cfix = 27.11% ash = 28.11%, humidity = 33.13%

MATERIALS AND METHODS

All of the research measurements and definitions have been realized in the Laboratory of the Foundry. The industrial process is realized in the New Foundry of the New Ferronikel in Drenas, starting from measuring the amounts and the process values which are represented graphically.

The materials and methods used in this study are explained in a few other studies I have published (Bajraktari-Gashi, 2012; Gashi *et al*., 2011a, b, 2013, 2015; Zabeli *et al*., 2016; Bajraktari-Gashi and Zabeli, 2017; Bajraktari-Gashi *et al*., 2018)

RESULTS AND DISCUSSION

Processes in the rotary kilns during the years 2012-2017. During the laboratory and industrial research

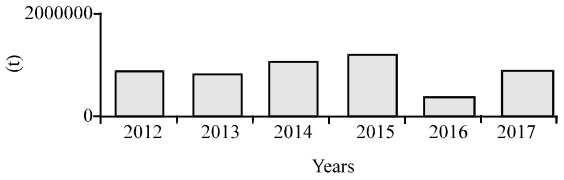

Fig. 1: Graphical representation of Fe-Ni ore spent during the analyzed years

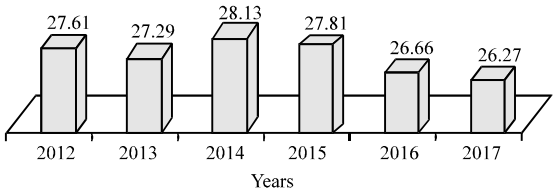

Fig. 2: Graphical representation of the average humidity of Fe-Ni ore

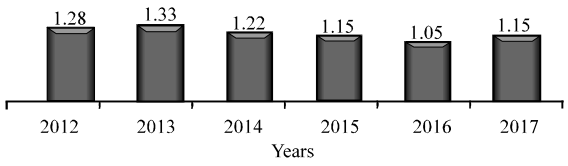

Fig. 3: Graphical representation of the average of Ni in Fe-Ni ore

realized in the New Foundry of the New Ferronikel in Drenas in the part of the furnaces during the years 2012-2017, we have obtained the following results represented graphically. Figure 1, we have represented the amount of Fe-Ni ore spent in the rotary kilns during the years.

From the graphical representation we notice that the amount of ore from 2012 has had an increase in supply to the rotary kilns until the year 2015. As a result of renovations in the Foundry work wasn't carried out for 6 months in 2016 while during the year 2017 only one electrical furnace worked.

From the graphical representation (Fig. 2), we notice that the humidity average of the Fe-Ni ore is high which is why it is requested to spend more fuels in rotary kilns.

During the last years (2015-2017) the amount of ore supply to the two rotary kilns is 70% from Kosovo and the rest is imported (Fig. 3-5).

From the analyzed graphical representation in the foundry, we notice that the amount of fuel is high because fuel plays an important role in the prereduction process in rotary kilns.

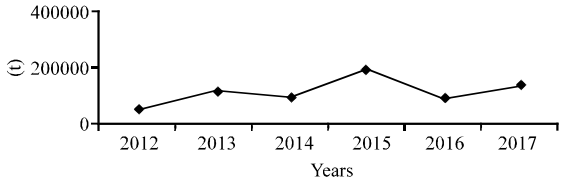

Fig. 4: Representation of the usage of fuels in rotary kilns

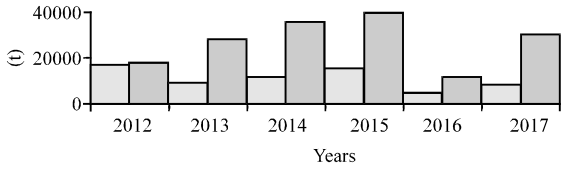

Fig. 5: Graphical representation of the spent amount of pet

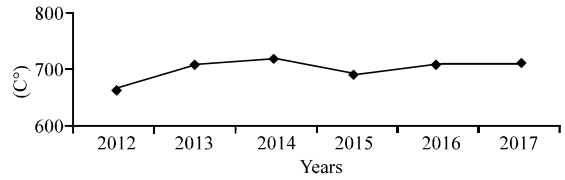

Fig. 6: Graphical representation of the temperature of calcine during the years 2012-2017

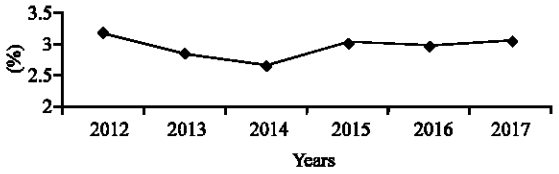

Fig. 7: Graphical representation of Cfix for two rotary kilns

From the year 2011 pet kok has started to be used in the rotary kilns and every year its amount increases in response to a decrease of the amount of heavy oil used.

From the graphical representation (Fig. 6), we notice that during the year 2015 the average temperature is lower than during the analyzed years (except 2017). The reason is that during 2015 the amount of ore spent was higher.

The percentage of Cfix in rotary kilns plays an important role in the prereduction process and lowering the crystalline humidity. Indonesian stone coal and Russian coal used in the rotary kilns as fuels have a high Cfix over 40% whereas Kosovo's lignite is characterized by a Cfix of about 18% (Fig. 7).

In the foundry for a ton of calcine, 45 kg of Cfix is needed. To reach this amount in the case of using Kosovo's lignite in the load of rotary kilns, we need to insert big amounts which impacts on gaining a low quality calcine which consists of products of lignite (ash, burning substance, etc.).

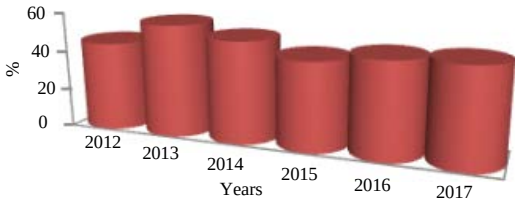

Fig. 8: The amount prereduction scale in rotary kiln

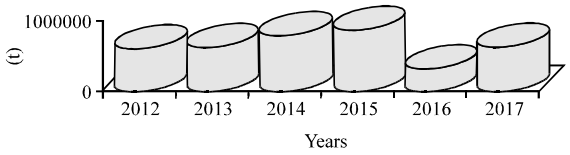

Fig. 9: Graphical representation of the average amount of calcine for two rotary kilns

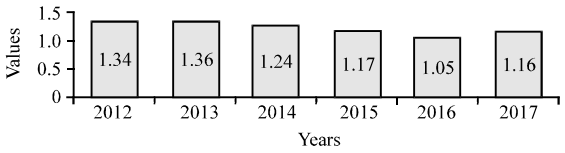

Fig. 10: Graphical representation of the percentage of Ni in calcine

Table 1: The calculation of the amount of Cfix spent per ton of calcine in rotary kilns

2012	2013	2014	2015	2016	2017
25839.95	26892.57	33822.15	37328.276	13136.38	26743.82

The calculation of the usage of the amount of Cfix in relation to the amount of calcine during the analyzed years:

45 kg Cfix/ton of calcine

The amount of Cfix calculated for the amount of calcine during the year 2012:

The amount of calcine 574221(t)×
45(kg)/1000 (kg) = 25839.95(t)

The prereduction scale in rotary kilns depends on the preparation of the Fe-Ni ore and on the amount of fuels which enter the process Table 1.

From the graphical representation (Fig. 8-10) we notice that from the years 2015-2017 the average percentage of Ni is lower as a result of the ores used in the Foundry being local ores.

CONCLUSION

From the laboratory and industrial research realized in the New Foundry of the New Ferronikel in Drenas, we can conclude that during the analyzed years in the calcine production process in rotary kilns, the Fe-Ni ore and fuel have the main impact. Therefore, a betterprocessing of the ore and fuel, their homogeneity, the drying of the ore before inserting it in the rotary kilns will contribute to a more successful process in the rotary kilns.

The big amount of fuel with a low caloric value with the purpose of increasing Cfix in rotary kilns, affects the loss of the amount of calcine. During the research, we have noticed that in most cases the ore and fuel enter the process in big pieces.

During the analyzed years the main supply of Fe-Ni ore comes from Kosovo where the composition of the ore from Cikatova involves 11.1% of CaO. In the case of our research the ore belongs to the type iron-silicate (year 2017 Kosovo's ore, layerof ore). The research results show that for the organization of the prereduction of nickel oxide ores in production conditions, it is needed above all the maximal increase of temperature of the process and for the processing the ores with a higher amount of calcium oxide should be used.

In 2014 and 2015 the amount of Fe-Ni ore was higher than in the analyzed years, the reason is that the Foundry had some renovations in the rotary kilns and the electrical furnaces which led to a lower amount of ore.

RECOMMENDATIONS

To install additional facilities for preparing the ore todecrease humidity, e.g., installing a new drying device with higher capacity that covers the capacity of tworotary kilns installing a device for comin nuting ingrains of the ore. Possibility of avoiding the dust in the Factory. Real quick steps to be taken in the New Ferronickel Factory for cominnuting the ore in grains, real quick steps to be taken for homogenization of the ore because nothing has been done on it for years in addition a very important issue that is worth mentioning is also that the flame-resistant material of the kilns is very much damaged and the kilns work in a bad condition.

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