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Review Paper

The Impact of Pet-Kok in the Technological Process of Production of Fe-Ni in the New Foundry of the New Ferronikel in Drenas

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New foundry of the new Ferronikel in Drenas[2]

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Abstract: In this paper we have analysed the impact of pet-kok on the increase of the quality of the calcine and the reduction of the cost of Fe-Ni production in the new ferronickel foundry in Drenas. The experimental and industrial research have been analysed during the years 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016 and 2017, where it was analysed the decrease in the amount of heavy oil since 2011 where pet-kok begins to be used. Industrial and experimental researches of attachments during 2009 and 2013, during the research we have proved the amount of pet-kok used reduces the cost by 30-40% compared to the amount of heavy oil. Growth of remelting temperature over the analysed years, reduction of attachments in rotary kilns, stability of fire-proof material in kilns in the case of reduction of the attachment, reduction of cost associated with reduction of the gasses which have a cost during their recycling process, including decommissioning channels, termination process and transportation are some of the advantages of using oil pet-kok as fuel in rotary kilns. The advantages in the metallurgical process achieved with the growth of pet-kok fuel have influenced every year that its quantity increases in relation to the heavy oil, both of which are used as fuel in a rotary kiln to increase the temperature, which is one of the major factors in increasing the quality of the calcination in the rotary kiln.

***Keywords**: humidity, pet-kok iron-nickel, rotary-kiln, heavy oil.*

Introduction

In the new ferronickel foundry in Drenas, several types of silicate and oxide compounds are used, with high moisture content, with an annual average of 30%, and therefore the preparation of the raw material requires high temperatures within the rotary kiln. The load for the rotary kiln in the new Ferronickel foundry in Drenas consists of Fe-Ni ore and various types of lignite and coal: Kosovo lignite (dry), Kosovo lignite (wet), Struga lignite, steam coal, limestone, slag, biomass, coal-Russia, while heavy oil and pet-kok as a combustion material in rotary kilns, are entered through special kiln parts that influence the temperature rise as a major factor for the high quality calcine benefits.

From the experimental and industrial researches of the analysed years presented in the paper, we notice that the amount of pet-kok compared to the amount of heavy oil has reached the 60% and 40% heavy oil ratio, while in this year according to the sources of the foundry was planned that the ratio pet- kok heavy oil to be 80% - 20%, *i.e.* reduction of the amount of heavy oil, as a result of temperature rise, reduction of attachments in rotary kilns and reduction of the amount of fuel from the financial aspect.

Materials and Methods

During the part of the experimental and industrial work during the years 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016 and 2017 we have observed the spending of ancillary substances in the rotary kilns in the new foundry of the new Ferronickel in Drenas (while analysing the spent amount of heavy-oil and pet kok from many ancillary substances that are used in the new foundry of the new Ferronickel in Drenas). As our survey we have the spent amount of the ancillary substances of heavy oil and pet-kok. We have realized the chemical structure of pet kok in the laboratory of the new foundry in the new Ferronickel in Drenas.

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First of all we measure 1g of pet-kok, and then we put the measured quantity in the dryer furnace at a temperature of 105-110°C, for two hours. Then we take the sample out of the furnace and let it cool down for about 45 minutes, where it is then measured on an analytical scale. The weight loss represents the moisture.

$$\%L = \frac{(m_2 - m_3)}{m_2 - m_1} \times 100 \qquad (1)$$

where:
m_1- the mass of the empty container,
m_2 - the mass of the container with the 1g sample,
m_3- the mass of the container with the sample after drying.

Determination of ash
We measure 1g of pet- kok in small and uncovered bowls of porcelain. Then we put this sample in the laboratory furnace, at a temperature of 800°C, for four hours.
After the sample cools down, we define the ash:

$$\%A = \frac{(m_2 - m_3)}{m_2 - m_1} \times 100 \qquad (2)$$

where:
m_1 -the mass of the empty container,
m_2 -the mass of the container with the 1g sample,
m_3-the mass of the container with the sample after burning.

$$\%\mathrm{M_d} = 100 - (L + A) \qquad (3)$$

where:
M_d-burning substances,
L-moisture,
A-ash.
Determination of sulphur

$$\%S = \frac{(m_2 - m_{1)x}F}{g} \qquad (4)$$

where:
m_1- the mass of empty container (g)
m_2 - the mass of container with the sample after the singe
F- coefficient of molecular masses

$$F = \frac{M[S]}{M[BaSO_4]} = 0.1374 \qquad (5)$$

Figure 1. Laboratory furnace at a temperature of 800-1000°C

Table1. Composition of pet- kok

Composition of pet -kok				
Burning substances	**Ash**	**Sulphide**	**Moisture**	**Caloric value**
12%	0.4%	4.3%	1%	8360[kcal/kg]

Table 2. Composition of heavy oil

Nr.	Parameters	Methods	Unit	Sample
1.	Density: at 50°C at 15°C	ASTM D 1298	[gr/cm^3]	0.927 0.949
2.	Viscosity: at 50°C at 100°C	ASTM D 445	[cSt]	208.4 27.4
3.	The point of ignition in An open container	ASTM D92	[°C]	172
4.	Amount of water	IP 386	[%]	0.11
5.	Sulphide	EN 24260/07	[ppm]	1.065
6.	Caloric value	ASTM D 1552	[kcal/kg]	9413
7.	Amount of ash	ISO 6245:1993	[%]	0.25

Discussion

From industrial and experimental research of the analyzed years 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016 and 2017 we see that there is a rise in the quantity of pet -kok which in the rotary kiln has begun to be used from 2011 and the reduction of heavy oil in rotary kiln year after year in which the increase in quantity has been shown graphically, Fig.1. From the Figure presentation we see that from year to year we have increased pet -kok compared to heavy oil.

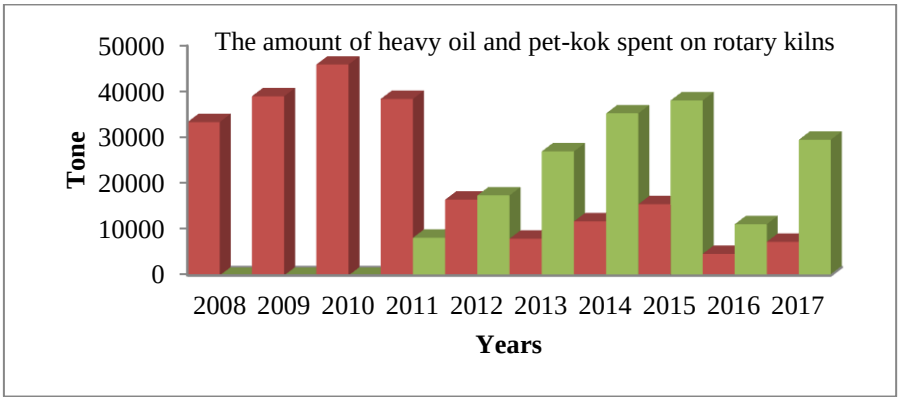

Figure 2. Graphic representation of the quantity of heavy oil and pet-kok spent in the rotary kiln

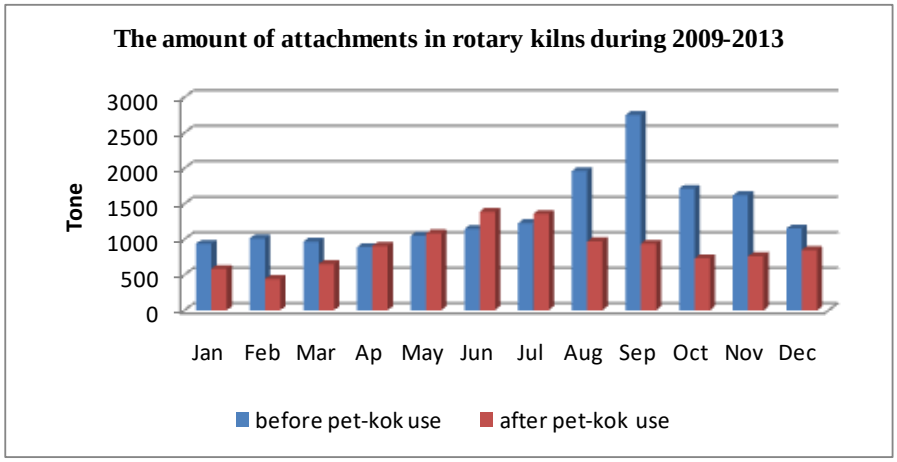

Figure 3 .Graphic presentation of the attachments during the 2009-2013 rotary kiln

Advantages in reducing of attachments and increasing temperature in the rotary kiln are some of the advantages that the foundry reaches with the use of pet-kok since 2011. In the following we will graphically present the report of attachments during 2009 where we have only the use of heavy oil and in 2013 where as fuels is also used pet -kok.

As a result of the reduction in the rotary kiln, we have a very good development in the rotary kiln, because the attachments cause problems in the realization of the metallurgical process, therefore their reduction with the use of pet kok influences the obtaining of the desired quality calcine and the high temperatures which goes in favour of preparing for an electric furnace, the reduction of the attachments in the rotating furnace affects the durability of the fire-proof material in the furnace where the rings formed in the case of attachments also mechanically damage the fire-proof material, the reduction of the attachments also affects the reduction of the cost processing of attachments. The most important factors of the increase of the calcine is the temperature where the metallurgical process is realized. From the graphical presentation we notice that there is a temperature increase with the use of pet-kok and, secondly, pet-kok in high temperature is burned by increasing the temperature of the calcine and there are no products left from its burning.

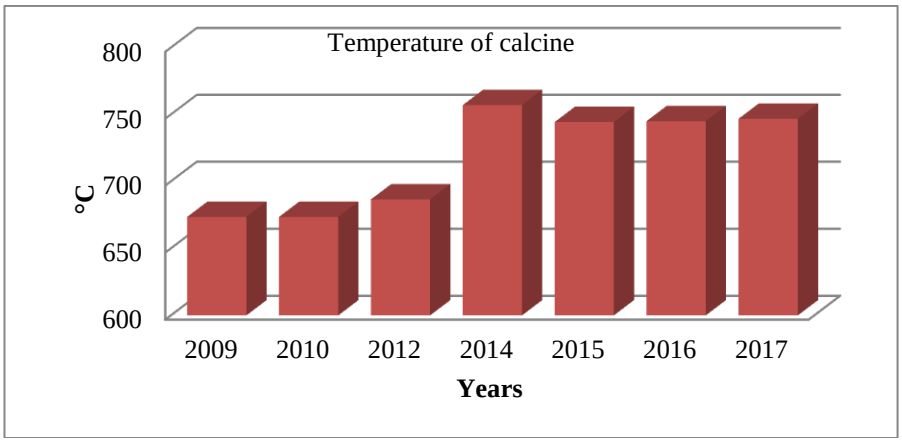

Figure 4. Graphical presentation of the calcine temperature in rotary kilns for the years analysed

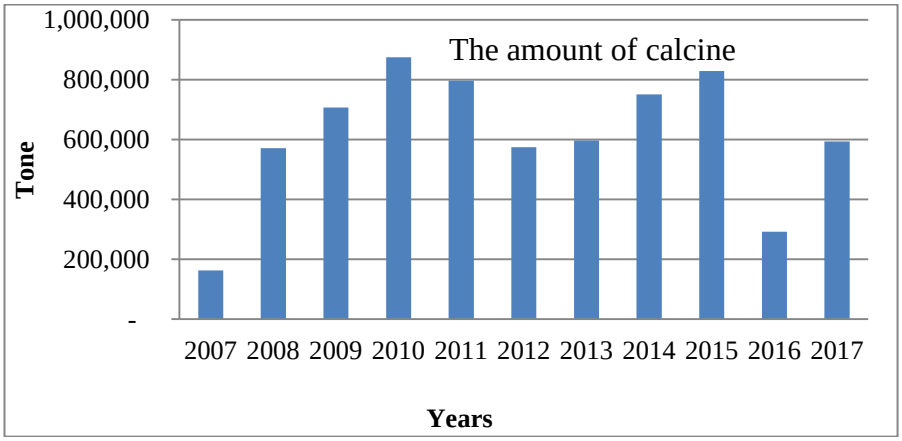

Figure 5. Graphical presentation of average value of calcine

With the use of pet-kok and the reduction of the heavy oil in rotary kiln we have the financial benefit as well, according to sources of foundry in recent years: 1ton pet-kok = 131.58 Euro; 1ton heavy oil = 379.54 Euro, but the price varies depending on the oil price on the market (as reference i got the current price of 2017).

From the graphical presentation we can compare the years 2008-2012, and 2010-2015, the years when only the heavy oil was used as fuel and the years when the pet-kok was used (2011-2017), the production of calcine during 2008-2012 is almost the same while the fuel consumption is lower by 32% in 2012 as a result of the increase in the quantity of pet-coke, we have a

comparison of the years 2010-2015, where in 2015 we have a reduction of the calcine produced to 5,2% compared to 2010, but in 2015 the fuel consumption dropped to 37%.

From graphic presentations, we see that the increase in the quantity of pet-kok affects the reduction of fuel costs and savings on the financial aspect.

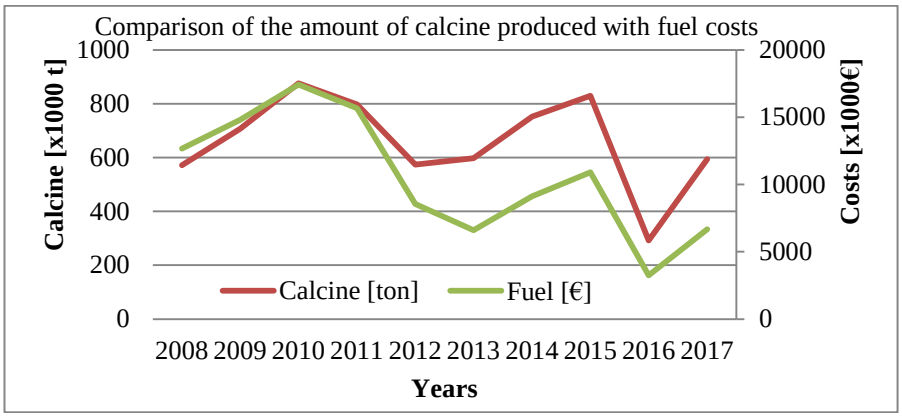

Figure 6. Quantity of calcine production and the total consumption of fuels (pet-kok and heavy oil)

Conclusion

From industrial and experimental research during the years analysed and presented in the paper, we can conclude that the use of pet-kok as a fuel material compared to the heavy oil has a positive impact on the realization of the metallurgical process in the rotary furnace in priority in comparison to the heavy oil starting from:

- Temperature rise in the rotary kiln,
- Reducing the attachments in the furnace (2009-9013),
- Obtaining of high quality calcine for the electric furnace,
- Fuel's financial reduction,
- Increasing the coefficient of utilization.

Some of the above-mentioned factors will make it possible to increase the use of pet-kok in the rotary kiln by reducing the amount of heavy oil in this year and will continue on.

Recommendations

- The types of Fe-Ni minerals in the new Ferronickel foundry in Drenas should have a new processing technology from the existing one,
- To repair the parts for the mechanical processing of Fe-Ni ore,
- To install a dryer to reduce the Fe-Ni ore moisture that covers the needs of the two rotary kilns (which was functional during 2010, where the results of the calcine benefit were higher see Figure5)
- The amount of pet-kok grows by decreasing the amount of heavy oil.

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