OPERATION OF THE BLAST FURNACE N.3 CSN WITH HIGH RATES OF COAL INJECTION [1]

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Abstract

The start of the injection of pulverized coal (PCI) in CSN occurred from the year 1997, with technology BMH, and with a maximum capacity of 200 kg / t of pig iron in the two blast furnaces. This paper aims to present the results obtained in the CSN with the injection of high rates of pulverized coal, reaching values of PCR above 210 kg / t with levels of coke rate less than 270 Kg / t of pig iron in the Blast-Furnace n.3, to reduce the most of his coke consumed and therefore reducing the cost of pig iron.

Key words: Pig iron; Blast furnace; PCI

Resumo

A planta de PCI da CSN foi construída em 1997 com tecnologia da BMH e uma capacidade máxima de 200 kg/t para os dois altos-fornos. Este trabalho apresenta os resultados obtidos na CSN com altas taxas de injeção de carvão pulverizado, atingindo valores acima de 210 kg/t de gusa com níveis de coke rate abaixo de 270 kg/t de gusa no alto-forno 3 reduzindo ao máximo seu consumo de coque e por conseguinte o custo do gusa.

Key words: Iron making; Blast furnace; PCI

1 *Technical contribution to the 3rd International Meeting on Ironmaking, September 22 – 26, 2008, São Luís City – Maranhão State – Brazil*

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1 INTRODUCTION

The injection of pulverized coal, like other hydrocarbons used for blast furnaces, is a technology that took big boost from the 80 decade, mainly because of the lack of coke in the steel industry worldwide in terms of economic and environmental pressures on coking and by the growing demand for steel in the world. . Moreover the interest in pulverized coal injection of consolidated in follows technical-economic viability:

- optimization of the sources of coal consumption, as has been reported in the literature of coal injection of different "ranks", since the anthracite to Lignite;
- reduction of rates operational production of the coke oven batteries, which can prolong their lives, avoiding frequent reforms or the need for an expansion to increase production;
- difference between the price of imported coal and coke imported, makes the injection of pulverized coal a practice highly profitable;
- ability to inject coal at rates higher than fuel oil, tar and natural gas, thus providing greater economic return to blast furnaces operation.

The injection of liquid or gaseous fuels, aims to replace part of metallurgical coke in blast furnaces. The limit for the injection of solid or liquid fuels has been linked to lowering the temperature of the combustion flame of the combustion zone. The injection of pulverized coal, requires special care because, for having a kinetic firing, lower than natural gas or fuel oil, there is the possibility of fines for non-coal reacted after the combustion zone, cause loss of efficiency thermal and permeability of the furnace. These fines could be retained in the drip zone of iron / slag, influencing the formation of carbon in iron or the reaction of reduction (C + FeO). As the pulverized coal can be injected at rates higher than the fuel oil / natural gas, has been a more intense reduction of the amount of coke loaded from the top. Reducing the amount of coke loaded at the top causes problems of the permeability at the cargo, which is identified as the main condition for limiting the growth rates of injection of pulverized coal, so that companies have greater requirement with respect to quality physical and metallurgical of materials charged, especially as regards the quality of coke.

2 HISTORY

Companhia Siderurgica Nacional uses injection of hydrocarbons into its blast furnaces since the year 1987, when natural gas was to be used in a level of 30 to 40 kg / t of pig iron. With the increased production of pig iron, the limited availability of natural gas and the stoppage of its coke battery number 3, there was a considerable increase in deficit of coke, increasing its dependence on foreign purchase of coke. In 1993 the CSN opened competition for the purchase of a system of pulverized coal injection for the rate up to 200 kg / t of pig iron. The system was purchased from KST (currently BMH, Germany). In June 1997, this system came into operation, beginning with the injection of pulverized coal in blast furnace 2 and 3, reaching the month of October the same year the monthly average of 157 kg / t in Blast Furnace 3 and on December this year the average 162 kg / t in the blast furnace 2.

During the period presented in this paper with the levels of injection practice, the dependence on external coke was dramatically reduced the levels of 4%. The rate of more economic injection of coal depends on the characteristics of each company, one should seek to promote the rate more cost effective.

3 THE SYSTEM PULVERIZED COAL INJECTION OF THE CSN

The system of injection of pulverized coal acquired by CSN is type phase dense with transport by nitrogen. Its a total maximum capacity of injection was 117 t / h and 37.5 t / h in the BF-2 and 79.5 t / h in the BF-3 and can use coal of hardness up to 42 HGI and volatile matter of 17 to 35 in pulverized coal.
The CSN`system has two griding and three stations of injection (one for the BF-2 and two for the BF-3) with two vases of injection at each station.
Figure 1 below gives a picture of the external view of the coal injection plant from CSN.

Figure 1 - Photo of the building of the the CSN's PCI plant

Figure 2 below presents a summary flow of coal from CSN.

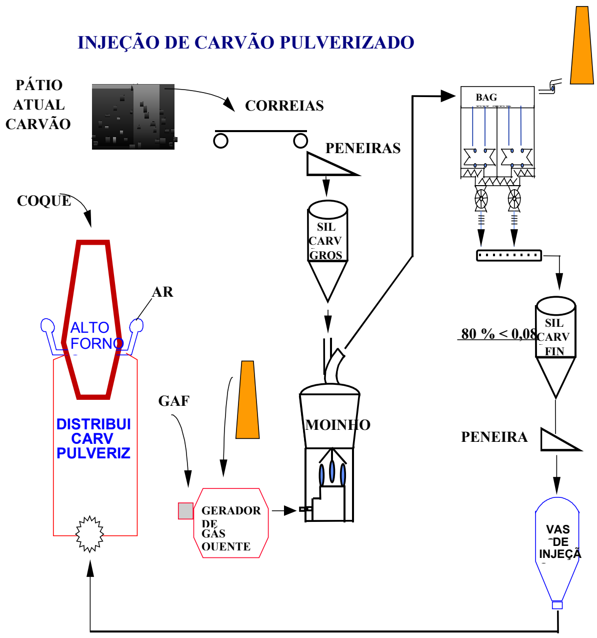

Figure 2 - Flow general summary of the PCI CSN's plant

3.1 Improvements in Pulverized Coal Injection System of the CSN

The injection system of coal from CSN was mounted in the last campaign. With the revamp of the furnace 3 in 2001 increasing its daily production of 9200 t / d for up to 11000 t / d, the ability of injection which originally was 200 kg / t, was limited to 170 kg / t. Aiming to increase this capacity, some improvements have been implemented so as to achieve a rate of coal injection of up to 90 t / h, which corresponds to a specific rate of coal in the blast furnace 2 of 250 kg / t for a daily production of 4,200 t / and 180 kg / t on the blast furnace 3 for a maximum production of 11,000 t / d.
The scope of This work was presented in 61º of the ABM Congress.

4 MATERIALS AND METHODS

4.1 Coal

The effect of the type of pulverized coal has been studied in CSN through a simulated burning and aims to maximize the rate of replacement (coal / coke) in blast furnace evaluating the mix of coal that provides the best performance and efficiency of burning. This matter was made in XXXV Seminar reduction of Iron ore from the ABM.
The systems used by the majority of blast furnaces allow the use of only one type of coal to PCI, this is high, low or medium volatile. The system deployed in the CSN allows you to mix two coals.
The system has ability to mix two types of coals. The practice is used to make blends from coal (high with low volatile and medium with high volatile). The measurement of coal in the simulator, sees its characteristic chemical and its efficiency of the burn. The application and control in industrial scale is calculated the rate of replacement of mixtures according to the parameters of quality.
Figure 3 below shows the rate of replacement used in the period 2007.

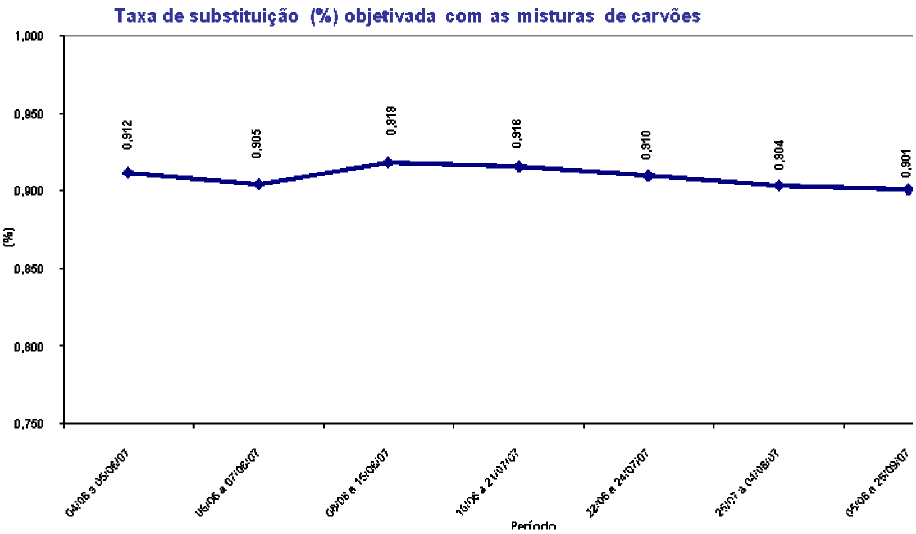

Figure 3 - Replacing rate Of the mixture of coal of PCI

4.2 Coke

The coke to be the main element of the load permeability of the blast furnace, took special attention to its relationship with characteristics of quality, especially with regard to its mechanical resistance to cold, its mainsize and its reactivity as can be observed in Figures 4 and 5 below.

In this period was produced and used a coke with the following averages characteristics: CRI - 19.1, DI (150 15) - 85.3% and AS - 62.6 mm. The mixture of coal used in this period was: LV 70% and 30% HV.

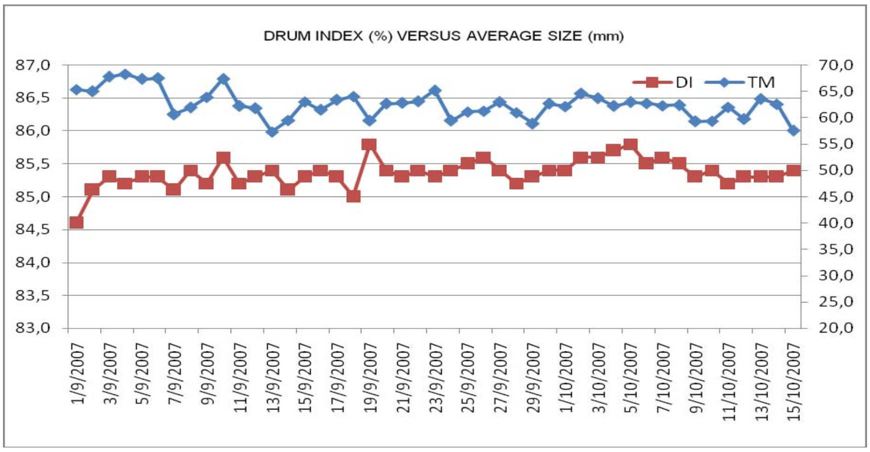

Figure 4 - Results of DI and MS of CSN`coke over the period.

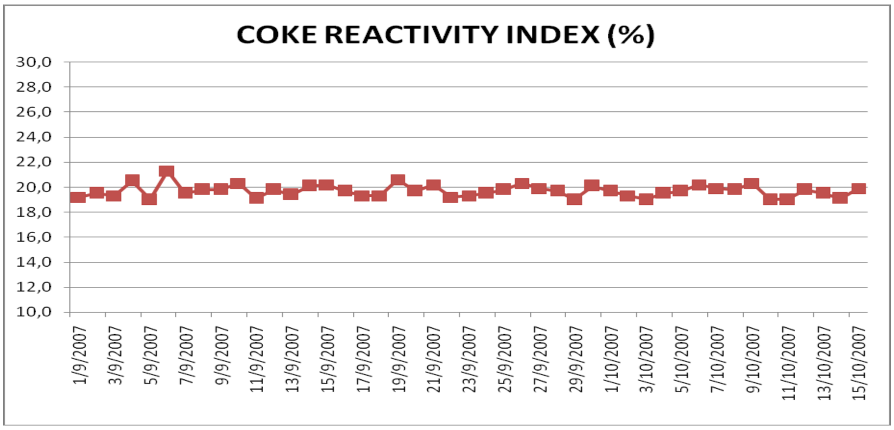

Figure 5 - Result of reactivity of CSN`coke over the period.

5 RATE INJECTION OF COAL VERSUS OPERATIONAL DATA OF THE BLAST FURNACE 3

As shown in the theory and practice, the performance of the blast furnace that is strongly influenced by the rate of injection of pulverized coal, because with the increase the coal rate the coke rate is reduced.

Figure 6 below shows the relationship observed between the coal and coke rate in the blast furnace operation 3 of the CSN. We can see that when the rate of coal exceeds the values of 200 kg / t, there is a reduction in the rate of fall of coke rate. This is due to worsening in the burning of coal caused by reduced oxygen in relation to carbon and drop in the temperature of flame in the race way.

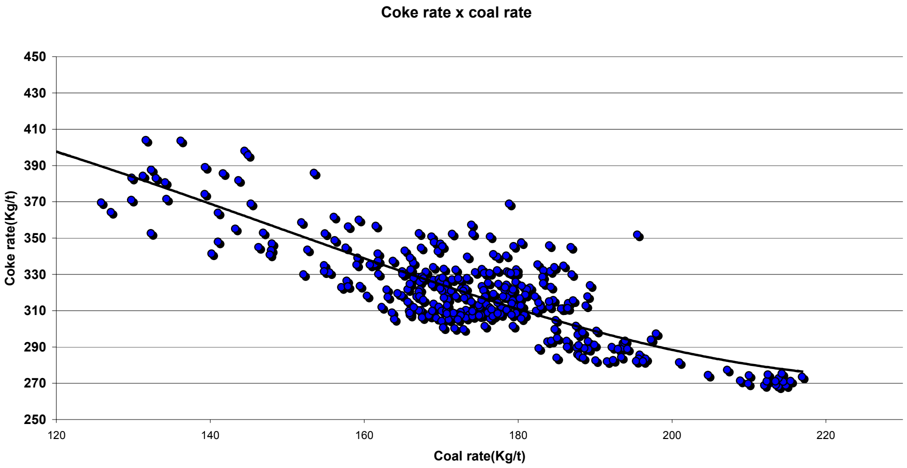

Figure 6 - The correlation of coke rate to Coal rate of CSN3 Blast Furnace

Another proof can be seen in Figure 7 below, refers to worsen in the permeability of the column load with the increase in the rate of coal. This permeability in this case is obtained by the index "k" below, calculated according to the equation which assesses the value of the permeability or reverse the resistance to the flow of gas, that is if this means value grows worse in the permeability of the cargo.

$$K = (((Bp + 1,033)^2 - (Tp + 1,033)^2) / TV^{1.7}), \text{ where}$$

Pp - pressure of the hot blast (kg/cm^2);
Tp - pressure from the top (kg/cm^2);
TV - volume of gas generated in tuyère (Nm^3/min).
The lifting of the index k observed in the chart with the increase in the rate of coal, due to the reduction of the thickness of coke in the column of cargo that hinders the passage of gases, and the increase in the volume of gas in the bottom of the furnace, with the Replacement of coke from coal.

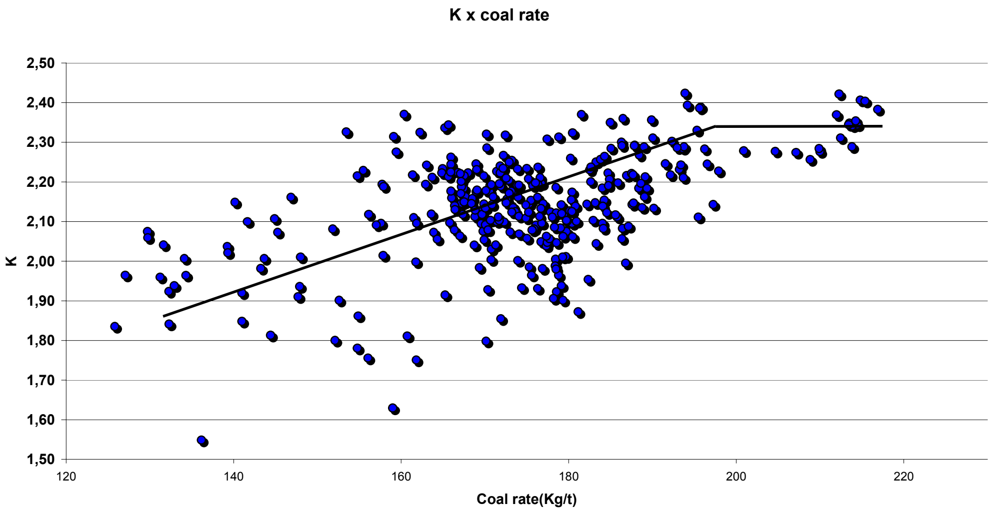

Figure 7 - The permeability decrease or increase K vs. Coal Rate

In Figure 8 below can observe the influence of raising of the rate on income of gas in the blast furnace. We see that with the increase in the rate of coal was a better return on gas, due to an increase in relation ore / coke caused by the reduction in coke rate. The change in the trend observed for values of PCR above 200 kg / t was a result of changes brought about in the distribution of cargo in order to improve the permeability of the column load and maintain the productivity levels in the furnace aimned. This can also be seen in the graph change in trend figures for the permeability of coal rate mentioned.

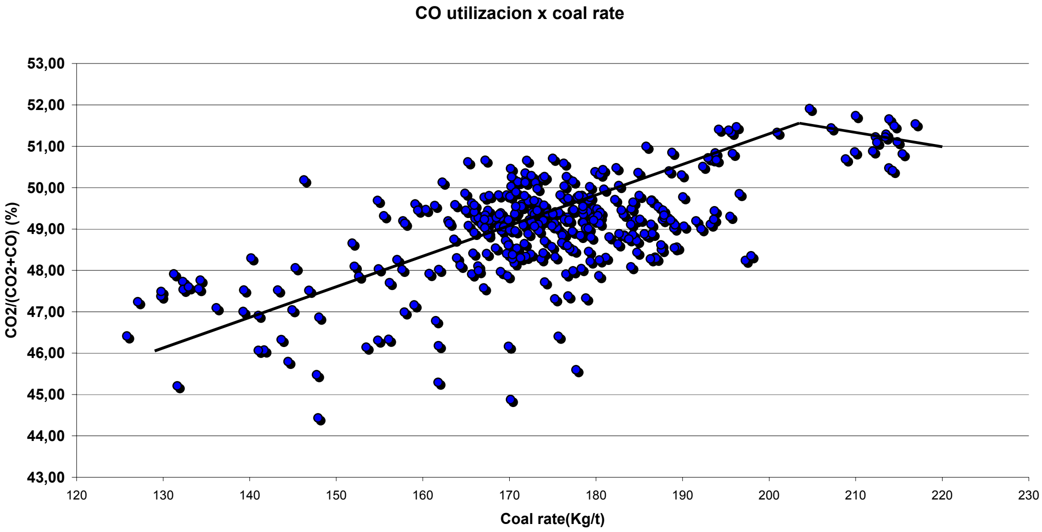

Figure 8 - The correlation of CO utilization vs. Coal rate of CSN Blast Furnace 3

In Figure 10 below noticed a reduction in the fuel rate of furnace with the increase in the rate of coal. This result was observed due to greater stability of the furnace, the better utilization of the gas, evidenced by the yield gas at the top (Figure 8 above) and an increase in temperature of air blown (Figure 9 below).

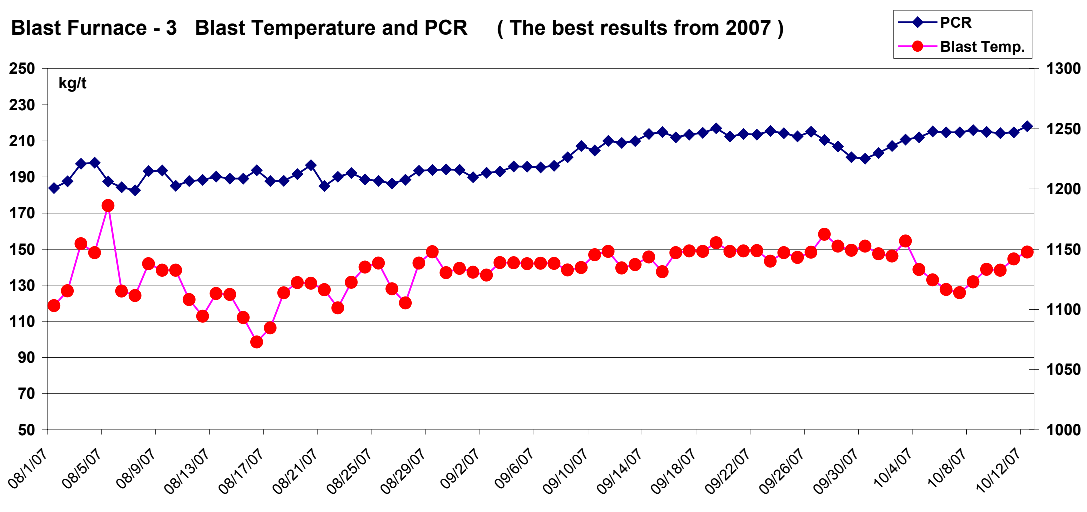

Figure 9 - Blast temperature x Coal rate of CSN Blast Furnace 3

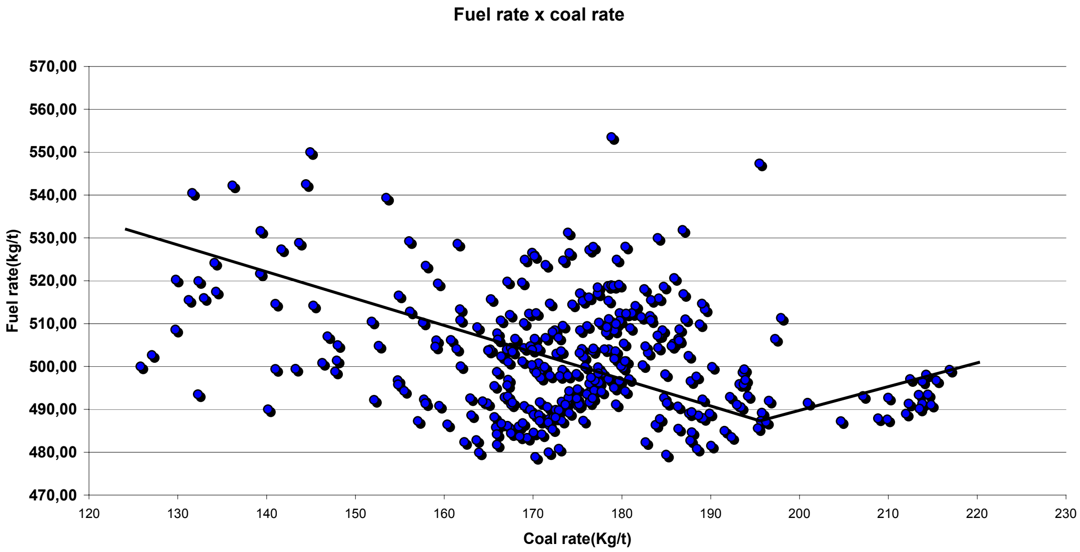

Figure 10 - The correlation of fuel rate vs. Coal rate of CSN Blast Furnace 3

Figure 11 below shows the relationship between the enrichment of the air blows with oxygen and the rates of coal practiced. The oxygen was used to improve the efficiency of burning coal and to offset the deterioration in the permeability of the column of cargo in order to maintain the level of production of the furnace in order to meet the schedule, as can be seen in figure 12 which shows the evolution of production in the period.

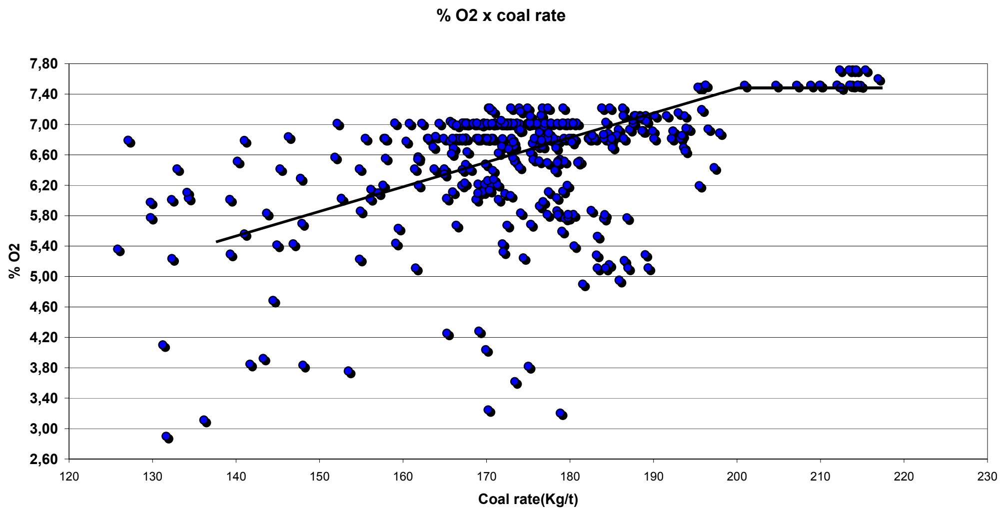

Figure 11 - The enrichment of the blast volume vs. coal rate of CSN's Blast Furnace 3

Recent European experience shows that controlling the productivity of furnaces with the increase in the rate of coal, has been conducted based on raising the percentage of oxygen enriched in the blast, as can be seen in Figure 12 below.

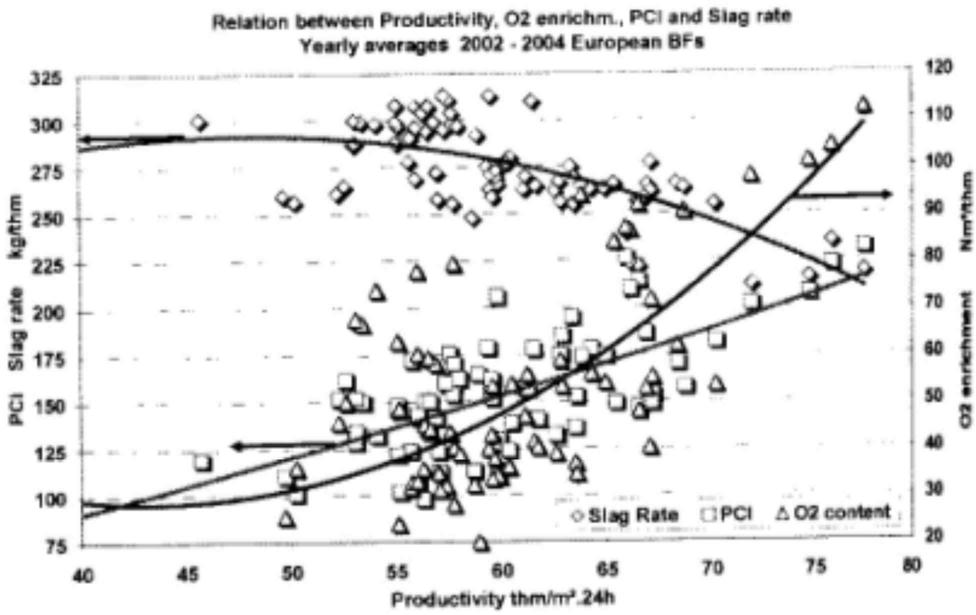

Figure 12 - Productivity oxygen related to enrichment, PCI and slag rate (European BFs 2002 - 2005)

6- RESULTS

The results are shown in the figures below where we can see the best results in rate of injection of coal already achieved in the history of the CSN blast furnace with a maximum daily value of 218 kg / t, on 12 of 0utubro, 2007.
The figure 13 shows the monthly development of fuel consumption of the blast furnace 3 in the year 2007.

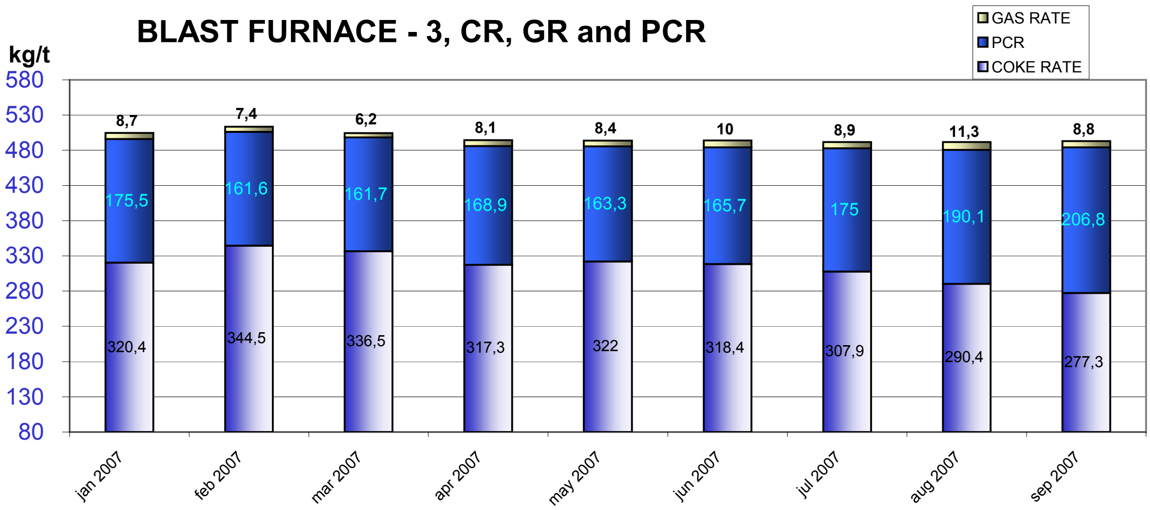

Figure 13 – Fuel consumption of blast furnace 3 in 2007.

Figure 14 shows the results of productivity and PCR of the blast furnace 3 in 2007 where we can see the maximum average value obtained in September.

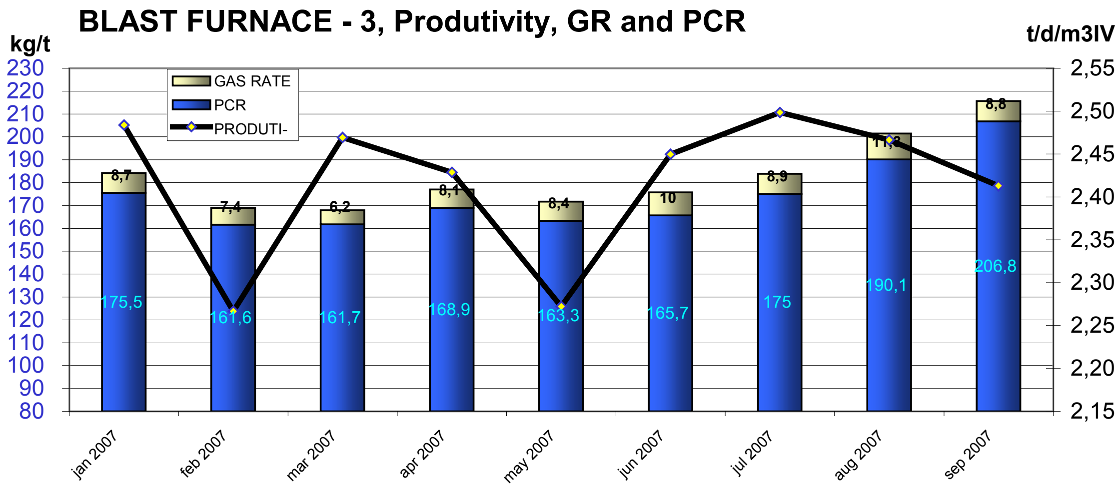

Figure 14 – Productivity vs. PCR of blast furnace 3 in 2007.

Figure 15 shows the evolution of the furnace PCR 3 for the period August to October 2007, a period of higher rates.

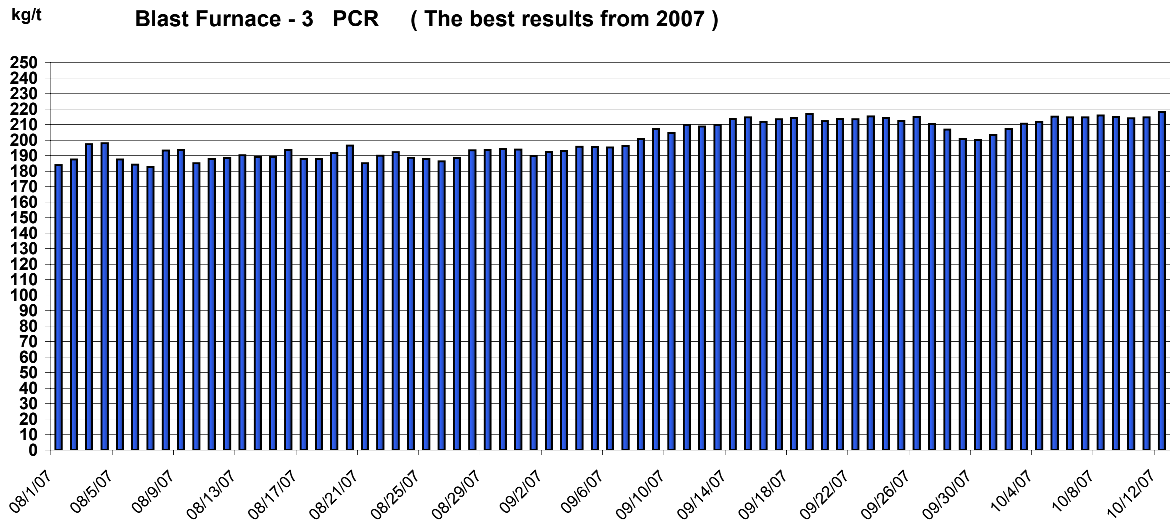

Figure 15 –PCR evolution of blast furnace 3 in 2007.

7 CONCLUSIONS

- The changes made in the Plant of PCI managed to provide a sufficient volume of coal to obtain rates of injection in the blast furnace 3 above of 210 kg / t.
- The use of coal in rates of high values requires a high quality of raw material, appropriate distribution of cargo capacity and high enrichment of air blown, in order to minimize the effect worsening permeability of the furnace.
- 7.3- With the values practiced was possible to minimize the average levels of 4% (0% in AF3 and 12% in AF2) deficit coke in the CSN over the period.
- For high values of injection of coal, the efficiency in replacing coke / coal has a gradual reduction due to the worsening condition of burning the mixture.

- With the current system of launches simple injection was possible to reach 218 kg / t of injection of pulverized coal, which opens the prospect of achieving greater ease with the maintenance of these values when the use of dual launches.

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