EXTENSION OF CAMPAIGN BLAST FURNACE Nº2 OF THE NATIONAL STEEL COMPANY[1]

Sebastião Jorge Xavier Noblat [2]
Francisco Nóbrega de Aguiar [2]
Reginaldo de Souza Roma [3]
Marcio José Mariano da Silva [4]
Marco Polo da Silva Peixoto [4]
Sandro Junior Batista [5]

Abstract
This work has by aim shows main action have been implemented in CSN' Blast Furnace 2 for extension that campaign, as how as its operational results in actual campaign after action implemented.
Key words: Extension; Campaign; Blast furnace.

Resumo
O presente trabalho tem por objetivo apresentar as ações principais implementadas no alto-forno nº 2 da CSN para prolongamento de sua campanha, bem como o resultado operacional obtido ao longo da atual campanha, com a implementação das ações.
Palavras-chave: Prolongamento; Campanha; Alto-forno.

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2 *Engineer Specialist of Blast Furnace – Management of Blast Furnace*
3 *Operation Manager of Blast Furnace – Management of Blast Furnace 2*
4 *Engineer Blast Furnace – Management of Blast Furnace 2*
5 *Technical Development Management of Blast Furnace 2*

INTRODUCTION

The blast furnace nº2 of CSN came into operation in 02-18-1991, with a planned campaign of 10 years of operation or a combined production of 12 million tons of pig iron with an average productivity of 2,0 t/d/m^3 IV.
At that time the major upgrades implemented in this were:

- Installation of top Paul Wurtz;
- Increase the pressure the top of 400 gr/cm^2 to 1,0 kg/cm^2 washing with gas through a bell with bischoff system of internal control;
- Equalization from the top silos with blast furnace and gas or nitrogen;
- Installation of 4º of the top bleeder (bleeder gas semi-clean);
- Installation of 2 probe fixed temperature of the gas on the burden;
- Installation of the third level probe with the capacity to achieve the level of tuyeres;
- Increase of the density of refrigeration plates in the body of the furnace of 340 for 1650 plates. In the previous design the plates were spaced covering only the region of low and medium stack. In the new design the density of plates was increase, covering the region above the tuyeres to the top. Beside, the previous plates of chambers were simple and the new design began to be 4 turns.
- Installation of measuring internal pressure in the furnace in stack 8 levels;
- Installation of skin flow on 7 points at level 4,5 m below the stock line;
- Installation of shell type free stand;
- Installation of refractory nitride carbideof silicon on the bosh, belly and low stack and refractory high alumina in the middle and upper stack;
- Installation of machine gun drill and Paul wurtz type of mud ;
- Installation of blow pipe type Paul Wurtz ;
- Increase of the number of tuyeres of 18 for 24 ;
- Increase of diameter of the hearth of 8,0 for 9,0 m;
- Increase of inner volume of the furnace 1550 to 1653 m^3;
- Increase of angle between the tap hole of pig iron 30º to 42º;
- Instalation of carbon super microporo the wall of the hearth.

Over the years the furnace had an excellent operational performance significantly exceeding the initial expectation of the design, reaching above the expected yields.

2 ACTION EXTENSION IMPLEMENTEDS FOR CAMPAIGN

Since 1997,after 6 years of operation, with a campaign acumulate of 9.805.487t of pig iron, began to be taken actions aimed at prolonging the life of the furnace, with the commitment to ensure the integrity of its shell, which should be maintained in perfect condition for reuse in the next reline, initially planned for 2001.

2.1 Preservation of Wall`S Furnace

Over the years while the high level of productivity of the oven ,as can be seen in the graph in Figure 1, occurred in an accelerated wear of the furnace refractory internal , between the region`s low level of stack and tuyeres. In order to meet the goal of maintaining the integrity of the shell of the furnace ,considering that close to 200 mm was scheduled and held in april of 1997 the first intervention in the furnace 2 with the objective of recovering the inner wall of the furnace refractory.

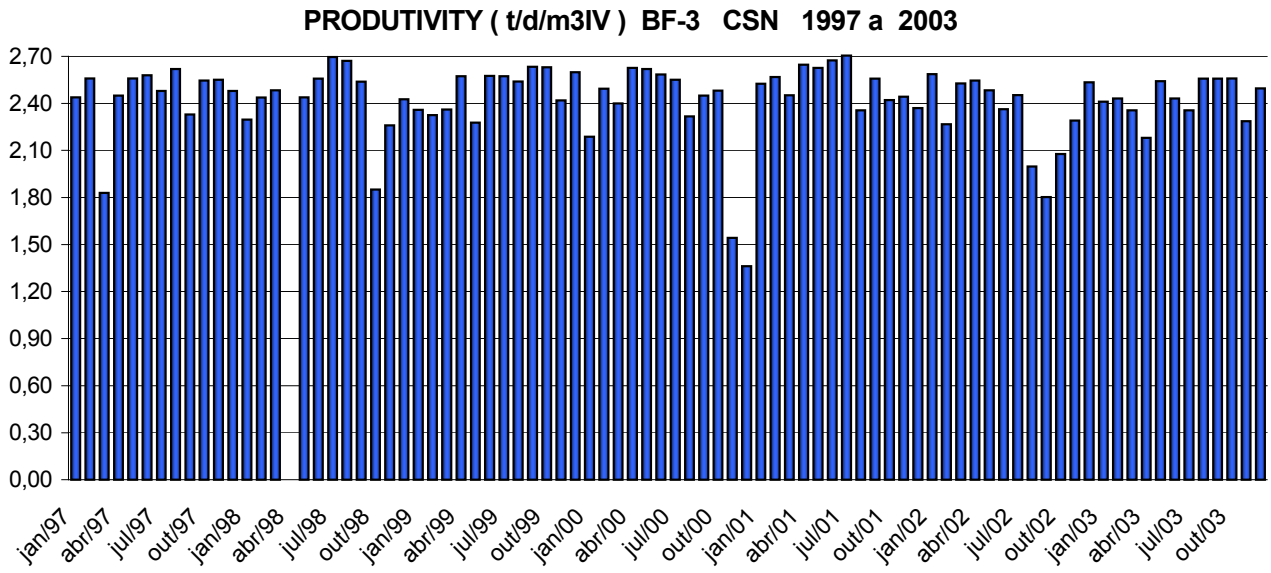

Figure 1: Productivity campaign of 1997 to 2003 of Blast Furnace 2

For such an operation was carried out of descent of the burden until the tuyeres for the rebuilding of the wall thickness of the furnace with high alumina refractory concrete. The method of application projection was used to guide the cold concrete specified. The projection was made between the tuyeres and the region of armur fixed the furnace as can be seen in the Figure 2 . The volume of material used in this activity was 383 t time and total stop to conduct this activity was 7 days. This aplication had an expectation of life for two more years.

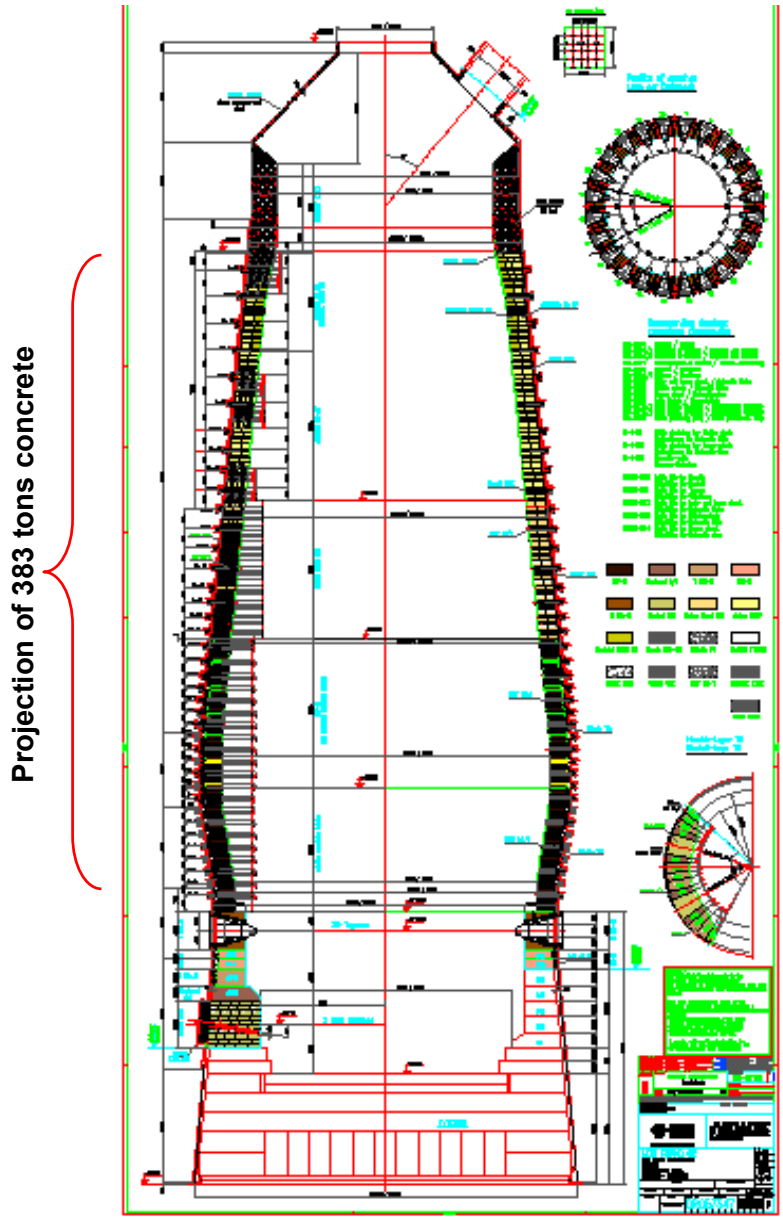

Figure 2: Projection was made between the tuyeres and the region of armur fixed (383 tons concrete)

On this occasion, was not carried out any intervention in the hearth of the furnace and is not, necessary to make the race of the salamander , and deletion of the hearth.

From the end of 1997 it was observed the rate of attrition of refractory applied was much higher than expected and is necessary to make new intervention for the recovery of the wall.

In april of 1998 the operation was repeated in 1997 using the same method of application before , this is the burden was lowered to the level of tuyeres and made new application of concrete with concrete projection of the cold . In this operation but the time to stop all the furnace was 15 days because a strong formation of skull found in furnace after of his stop and that he brought almost one week so that it could be removed and allow the completion of the implementation of concrete.

From 1999, because to the performance of the practical aplication of the cold was not reaching the two years initially, planned it was decided to plan the replacement of the entire refractory bricks by the furnace , which should occur at 2º half of 2000.
By carrying out this work it was decided to maintain the wall of the oven with the implementation of the hot projection of refractory concrete, which is now held in the region between the low level of stack and the top, a range of 4 a 6 months, depending on the need for the oven. In these aplications were used around 80 tonnes of concrete high alumina per stop. The Figure 3 presents the region this aplication.

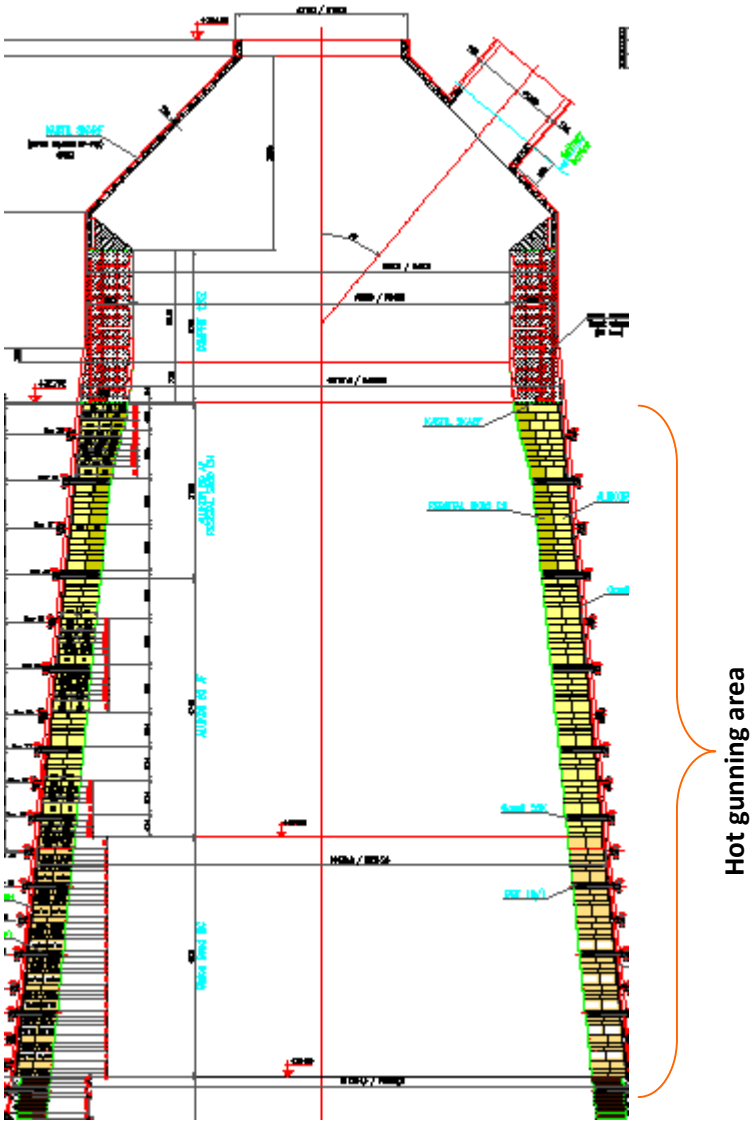

Figure 3: Hot projection of refractory concrete region between the low level of stack and the top

In november of 2000 was made up the furnace to the burden on tuyeres to carry out its reline. In the body of the furnace was replaced throughout the remainder of the refractory between the tuyeres and the fixed armur sets including the top. The new refractory bricks , was placed between the graphite tuyeres and the low stack , brick of silicon carbide in the average stack and brick high alumina in high stack.

2.2 Hearth Preservation

At that stop oven to be the case of a work of larger size and with expected life of the refractory for another 5 years, was previously conducted an assessment of the hearth of the furnace, through polling in several points of its wall where it was identified points with thicknesses of less than 400 mm of carbon , concluding by the need to replace the refractory of the shield in the region of the tap holes cast iron with extension of 105° horizontally and between the region of tuyeres and bottom the hearth ,as shown in figure 4. To carry out this activity was necessary to hold the race of the salamander, which was conducted by a hole in the tap hole 2. The total duration of this work was 22 days.

From 2005 the furnace began to show a strong tendency for training burden inactive as can be seen in the graph of Figure 4, interfering with the performance oven. Through surveys of the wall was found that the wall thickness of stack in the region of médium and low stack in the interface between the brick of carbide and graphite was significantly reduced.

Besides the thermocouples the hearth in the region between the two tap holes began to make elevation located in regions of repair conduced in 2000 as can be seen in the graph in figure 5.

It was decided to march/2008 plan, a repair of the furnace with stack replacement of the bricks of silicon carbide and high alumina, since the wear of the graphite bricks had stabilized at acceptable values and repairing the region of the shield similar to 2000, expanding to the area to repair the wall of the hearth to 120°.

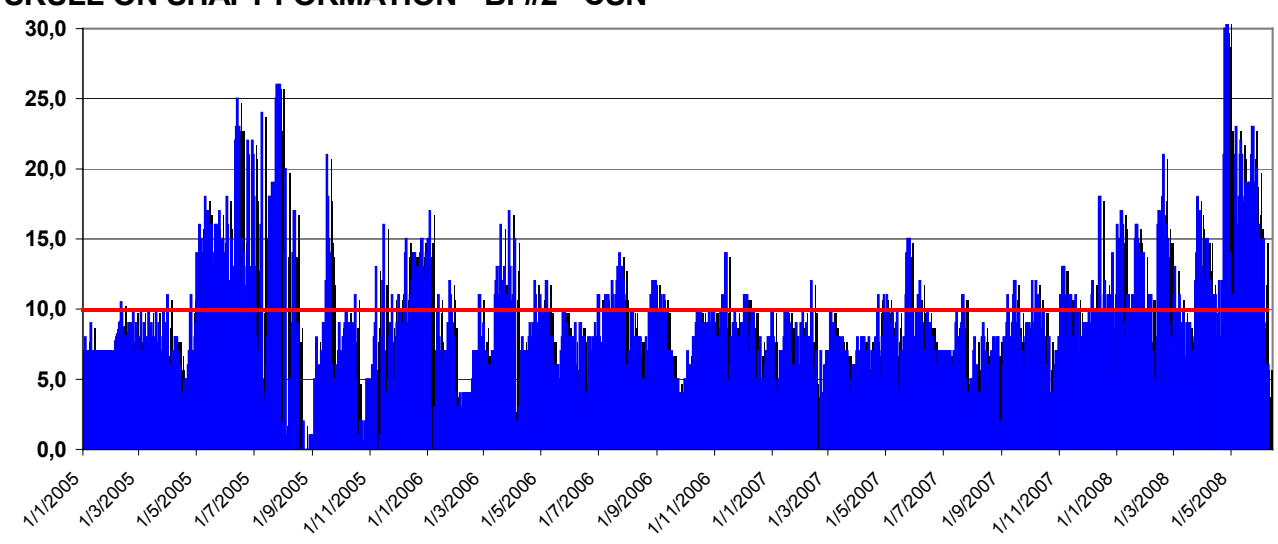

Figure 4: Skull formation since 2005 in BF#2

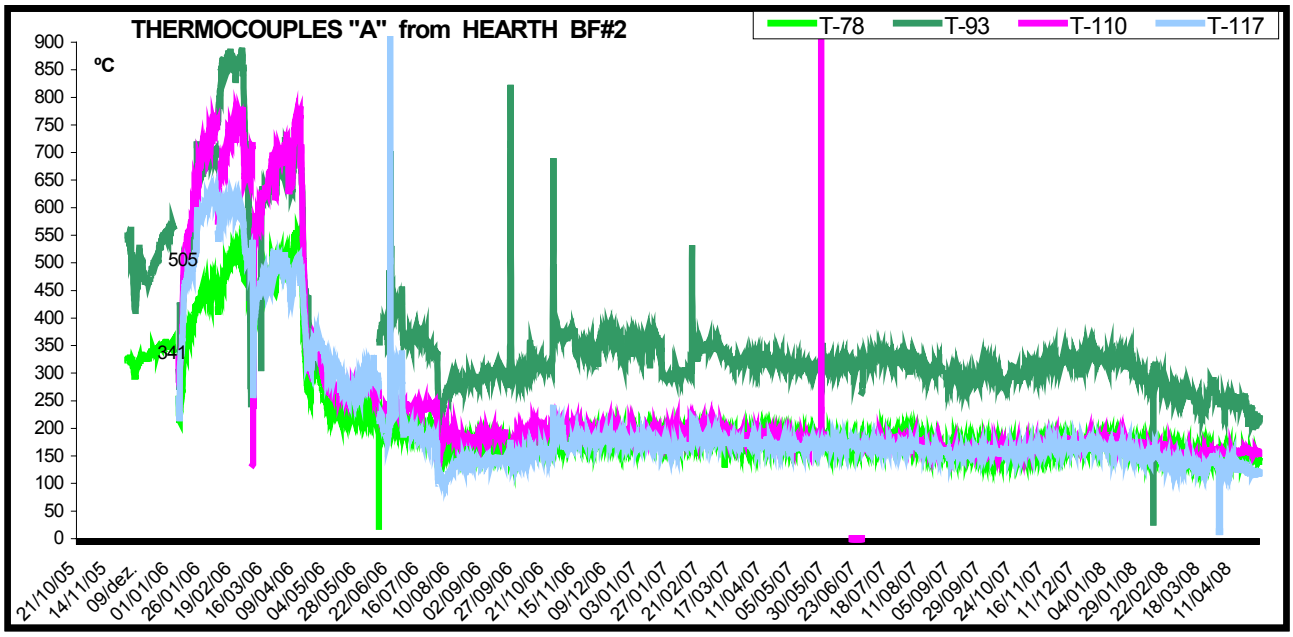

Figure 5: Increase temperature thermocouples the hearth in the region between the two tap holes in BF#2

By 2008, it was decided to expedite the recovery of the wall in the region of low stack (18m) projection with the hot concrete , replacing it if the method of application by the previous method of shottcreet that has made improved performance in terms of concrete rebound , increasing operational safety in the return of the furnace in operation and greater resistance to wear .
In the hearth to increase security in the region of the tap hole were taken the following actions:

- Construction of external wall of graphite thickness of 300 mm on the carbon of the shield in the region between the tap hole;
- Increase the angle of inclination of the machinery of the drill holes of pig iron from 10° to 16°;
- Tuyeres isolation of three tap holes on the cast iron;
- Introduction of the practice of racing in parallel holes in cast iron;
- Increase of the length of the tap hole of 2,6 m to 3,2 m;
- Loading of titanium , ilmenite in burden of the furnace;
- Reducing the small coke rate of 55 to 30 kg/ton;
- Reducing the PCR of 160 to 130 kg/ton;
- Reducing the rate of production of 4250 ton/d to 4100 ton/d.

3 RESULTS OBTAINED

The results of the campaign as na extension of the Blast Furnace 2 can be observed in the graphs of the following Figures 6 to 9 :

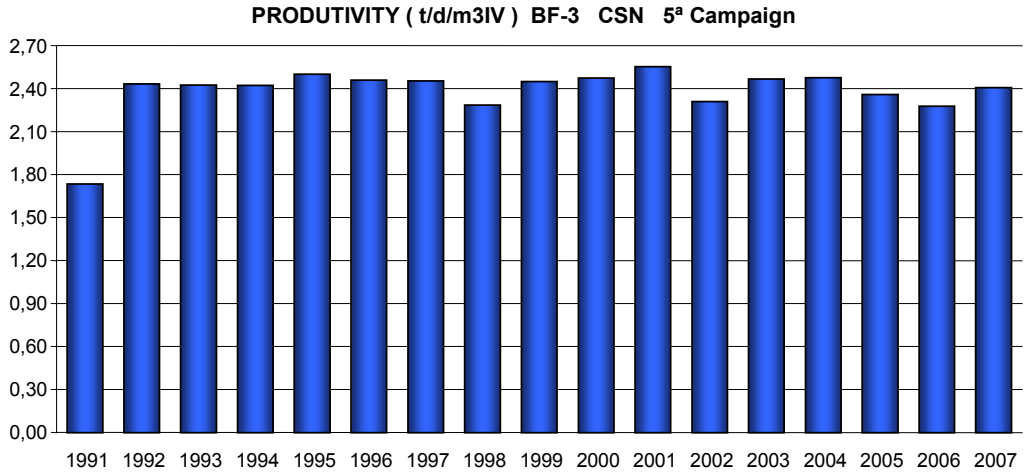

Figure 6: Productivity of campaign Blast Furnace 2

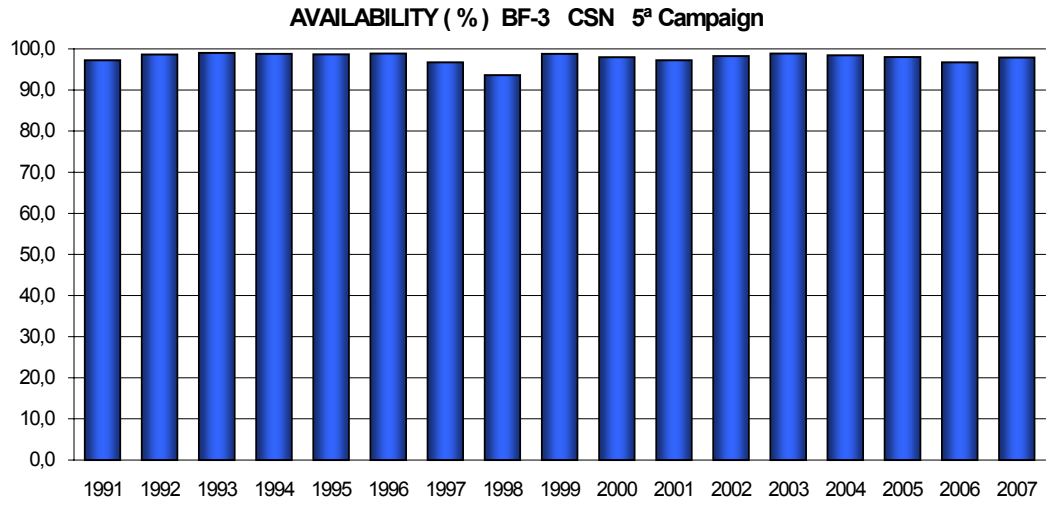

Figure 7: Availability of 5ª campaign Blast Furnace 2

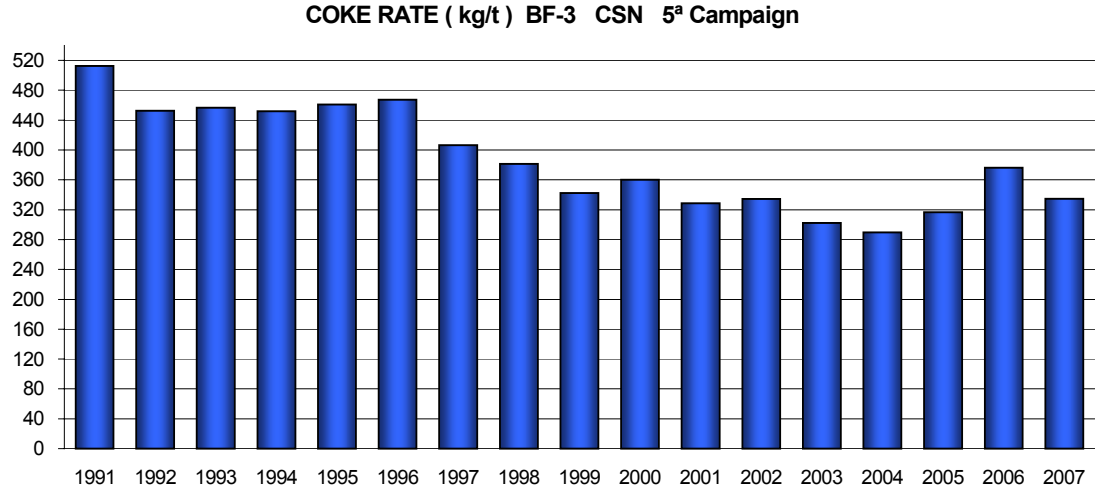

Figure 8: Coke Rate of 5ª campaign Blast Furnace 2

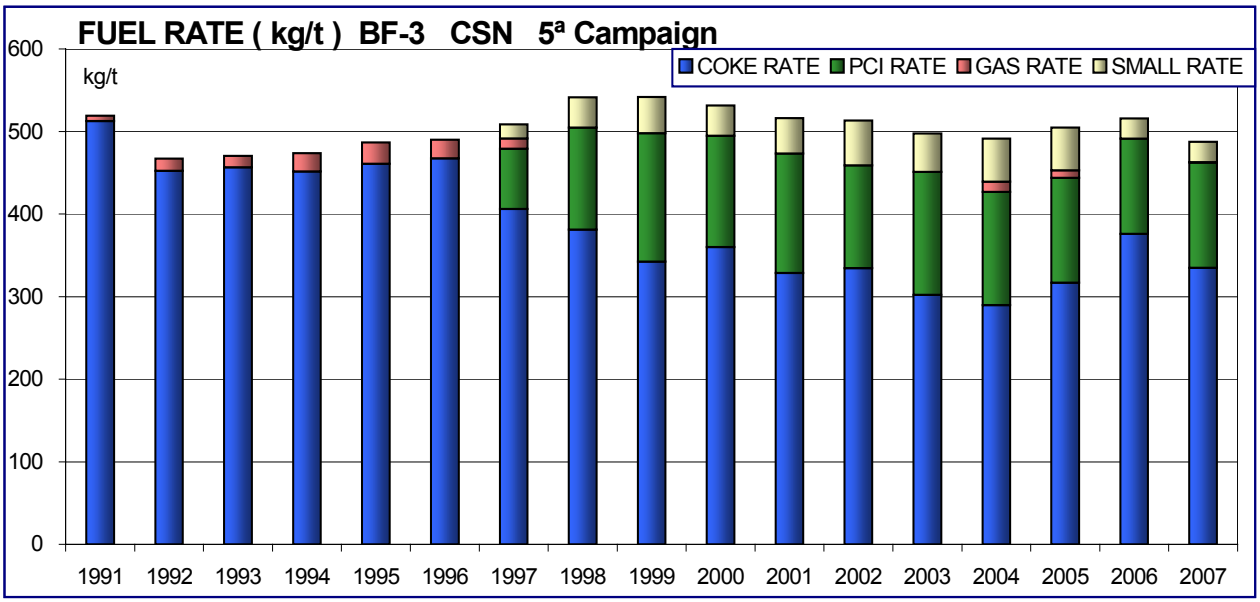

Figure 9: Fuel Rate of 5ª campaign Blast Furnace 2

4 CONCLUSIONS

4.1 The actions implemented to extend the life of the Blast Furnace nº2 were efficient and effective , helping keep the furnace operating in a stable condition and ensuring its operational continuity;

4.2 With the extension of the campaign produced the oven until May 2008 a combined production of 15.726.094 ton, exceeding in 5.920.607 ton aggregate production until 1997.

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