INCREASE OF BOF CONVERTER LIFE BY OWN SLAG COATING

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ABSTRACT

This paper presents a method for the improvement of the lining life of the BOF converter by slag coating, under nitrogen pressure. Own slag coating of converter lining is put in practice after steel tapping. Dolomite blocks are used like standard wear converter lining. Nitrogen blowing for own slag coating is carried out by oxygen lance. After steel tapping without slag, the converter is tilt in blowing position and the oxygen lance is let down in the lowest position. The nitrogen is blown under 10-12 barr pressure and 450-500 Nm^3/min rate, for 3 minutes. By this slag coating technology the performance of refractories has been improved from about 370 heats per campaign in reference year to about 800 heats per campaign at the end of two years of experiments, and therefore refractory consumption decreased from 5.25 kg/t under 3.00 kg/t and the cost of converter refractories decreased by 0.24 $/t. Another variant for improvement of the BOF converter lining life was the use of magnesia bricks for selective lining areas (trunion rings area and charging mouth). The own slag coating technology has been used also. In the case of this variant, the lining life of converter has been improved to about 800 heats per campaign at the end of two years of experiments and so the refractories consumption decreased under 2.45 kg/t. Because of the higher price of magnesia bricks and of the lower price of dolomite blocks, the cost for converter refractories has decreased only by 0.02$/t.

KEYWORDS: BOF converter, refractories, lining life, magnesia bricks, dolomite blocks

1. Control system for own slag coating

There are only to ways in order to remain on the steel manufacture market: quality improvement and cost reduction. One of the ways for cost reduction is to increase the lining life of converters. The nitrogen blowing by oxygen lance in the lowest position, at a pressure of 4-16 barr and a rate of 450-500 Nm^3/min. The converter lining sketch for dolomite variant and for magnesia bricks variant is shown in Fig. 1. As it can be seen, magnesia bricks have been used for selective lining areas only (trunion rings area and charging mouth). The control system for own slag converter coating is shown in Fig 2.

The chemical composition of the converter slag at tapping is presented in Table 1.

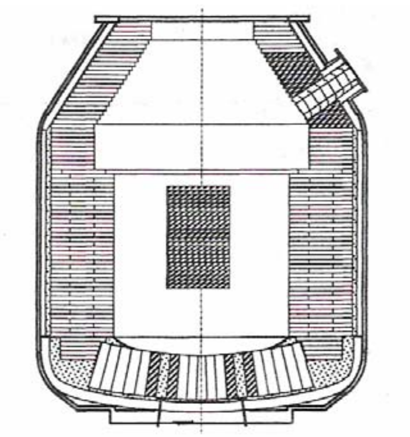

Fig.1. *Converter lining sketch*

***Table 1**. Chemical composition of converter slag, [%]*

CaO	Si0	MgO	Al_2O_3	MnO	P_2O_5	Fe
53-55	14-16	1.5-1.8	0.4-0.6	5.3-5.7	2.1-2.4	17.1-17.7

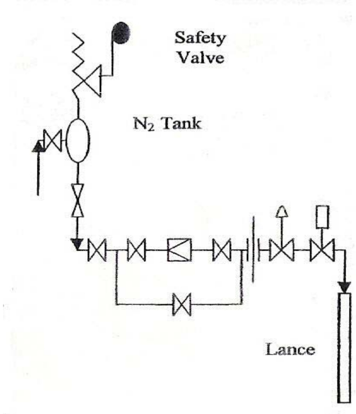

***Fig. 2.** Control system for nitrogen blowing*

After the steel from the converter and the using of slag free tapping system, the converter is tilt in blowing position and the oxygen lance is let down in the lowest position. Then the quickly closing valve for nitrogen is shut of and the lance valve also. The nitrogen is blowing for 3-4 min under 10-12 barr pressure and 450-500 Nm^3/min rates.

So the slag is spreading in radial and vertical direction onto the vessel refractories by the nitrogen spurts that come out from the nozzle of lance. The nitrogen has no negative reaction with slag and the lining of converter.

During cooling process the dreading slag is flowing on the converter lining. In this process the slag is “frozen” on the most used lining areas that are the coolest ones. So the coating of converter lining is obtained for the next heat.

After the first tests of own slag coating technology, the using cycle of nitrogen blowing was stabilized (Table 2).

***Table 2.** Cycle of nitrogen blowing for own slag coating*

Stage converter campaign [heats]	Nitrogen blowing regime
1-50	Without nitrogen blowing
50-150	One nitrogen blowing/24h
150-300	One nitrogen blowing/8h
After 300	One nitrogen blowing/3h

The own slag coating technology has the following advantages:

a) decreasing of the gunning masses;
b) increasing of the lining life;
c) decrease of the perforating risk for cylindrical area of the vessel.

2. The technological results of own slag coating technology

Figures 3, 4 and 5 present the results of the lining life (number of heats/campaign) for the three converters. As it can be seen, by slag coating technology, the lining life has increased from about 370 heats at the beginning to about 800 heats at the end of the experiments. The average values of the lining life for every converter and for the steelmaking shop are presented in Fig 6. The average increasing of the lining life in the first two years of own slag coating technology was about 160 heats/years (from 370 to 668 – Table 3). These average lining life values are used in the steelmaking shop for the economic estimation of the improvement of slag coating technology.

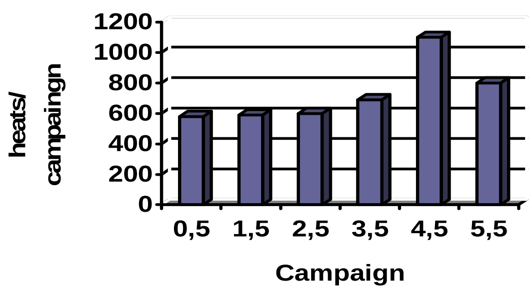

***Fig. 3.** Evolution of lining life (heat/campaign) for converter no. 1 – first year*

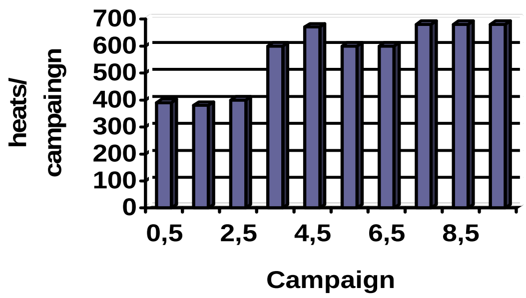

***Fig. 4.** Evolution of lining life (heat/campaign) for converter no.1 – second year*

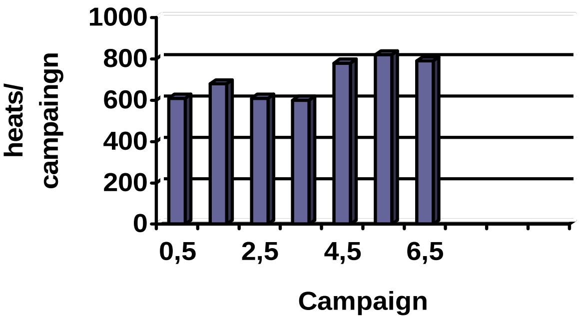

***Fig. 5.** Evolution of lining life (heat/campaign) for converter no.2 – first year*

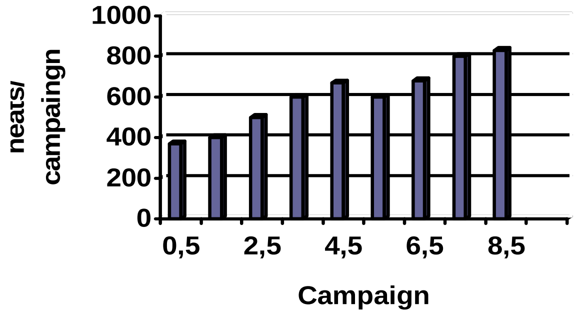

***Fig. 6.** Evolution of lining life (heat/campaign) for converter no.2 – second year*

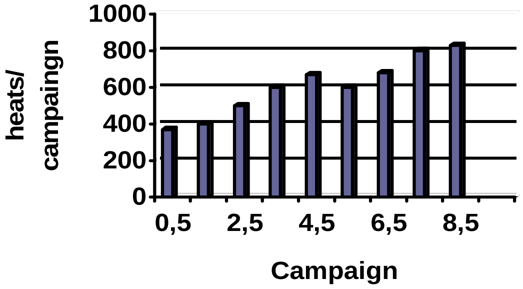

***Fig. 7**. Evolution of lining life (heat/campaign) for converter no.3 – first year*

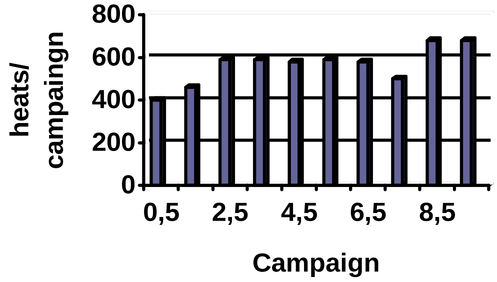

***Fig. 8**. Evolution of lining life (heat/campaign) for converter no.3 – second year*

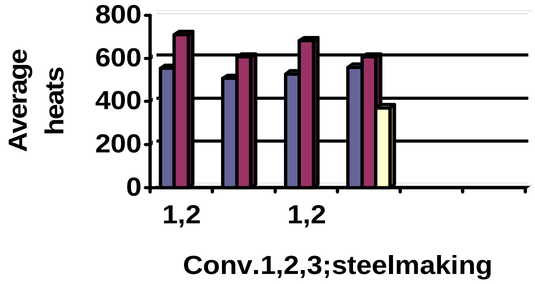

***Fig. 9.** Evolution of average lining life (heat/campaign)*
1 – the first year of experiments; 2 – the second year of experiments; 3 – reference year

***Table 3.** Evolution of average lining life (heat/campaign)*

	Conv. 1	Conv. 2	Conv. 3	Steelmaking
Reference year				370
The first year	554	597	528	560
The second year	715	606	682	668

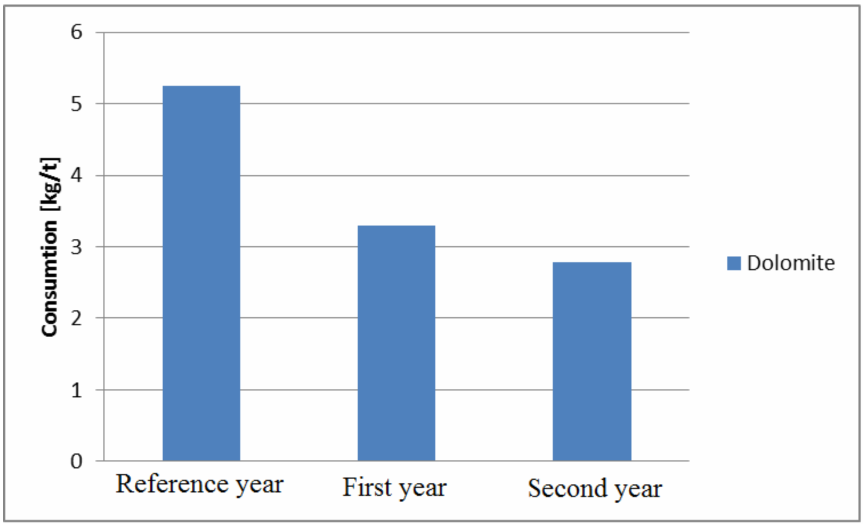

Fig. 10. *Dolomite consumption (dolomite variant)*

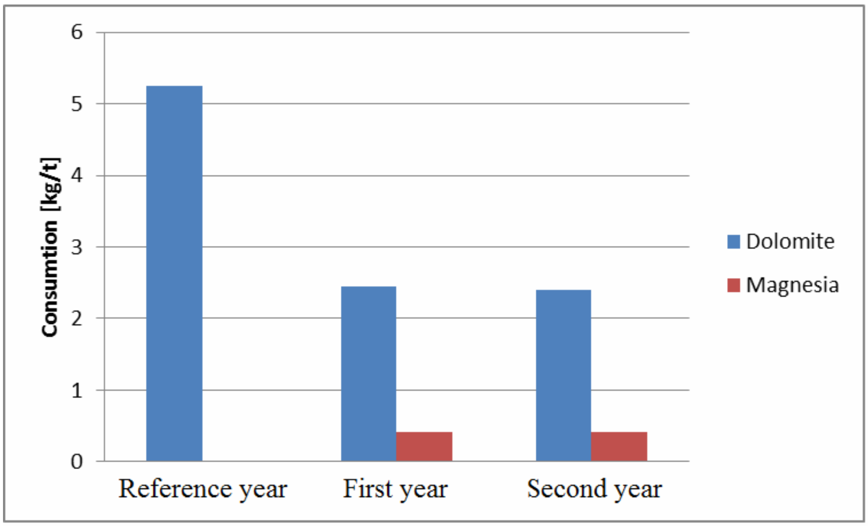

Fig. 11. *Dolomite and magnesia consumption (selective lining areas variant)*

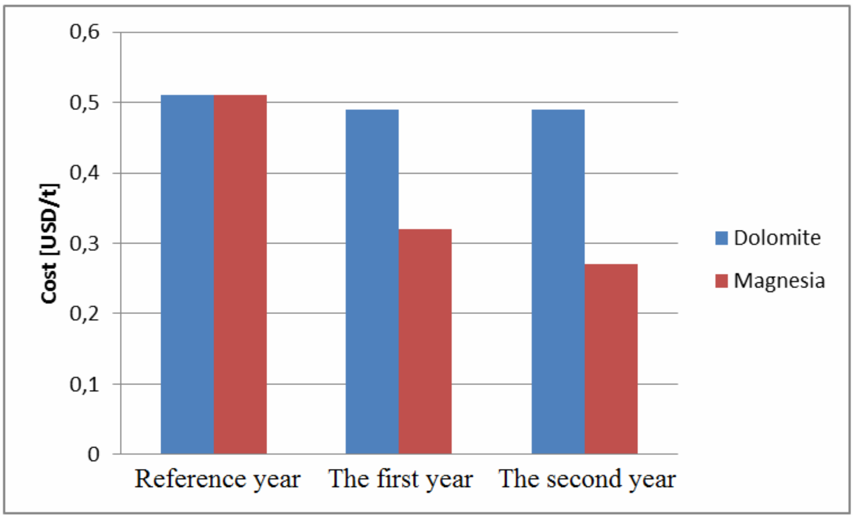

Fig. 12. *Evolution of specific cost for refractories*

In the first and second years of experiments two types of lining were used: one of dolomite blocks only and another of magnesia bricks for selective lining areas (trunion rings area and charging mouth). So it was necessary to analyse the influence of the own slag coating technology on every type of lining. In figures 7 and 8 present the evolution of the dolomite and the magnesia specific consumptions relative to the reference year, when own slag coating technology was not used at all.

It can be observed that dolomite consumption decreased with 2.47kg/t for the dolomite blocks only variant and with 2.85kg/t for the magnesia bricks selective lining areas variant, but for this last variant there is a supplementary consumption of 0.42kg magnesia bricks/t.

From this reason it was necessary to analyse these two variants from an economic viewpoint.

3. The economical results

The refractories specific consumptions and costs have been used for economic calculations in the case of the two variants.

The results are presented in Table 4 and Fig. 10. It can be observed that, using the own slag coating technology, the specific cost of the refractories was diminished from 0.5$/t liquid steel to 0.27$/t for the dolomite blocks only variant.

That means a 0.24$/t gross profit. In the case of the magnesia bricks selective lining areas variant, the profit is only 0.02 $/t only.

These economical results have been determined by the very low cost of dolomite blocks and a the high cost of magnesia bricks. So, until now, the best variant is dolomite lining and own slag coating technology.

Table 4. *Specific cost of refractories, [$/liquid steel, t]*

Year	Lining variant	
	Dolomite	Magnesia selective areas
reference	0.51	0.51
second	0.32	0.49
third	0.27	0.49

4. Conclusions

Using the slag coating technology the performance of the refractories has been improved.

The lining life of the converter has been improved from about 370 heats in reference year to about 800 heats per campaign at the end of the two years of experiments and therefore the dolomite refractories consumption decreased from 5.25kg/t under 3.00kg/t.

The cost for converter refractories decreased by 0.24$/t.

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