PRODUCTION OF BLAST FURNACE PIG IRON AND THE AMOUNT OF METALLURGICAL WASTE

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Abstract

Sustainable development concept assumes appropriately and consciously configured relationship between economic growth, environmental care and quality of life. When a large exploitation of natural resources and emerging waste, the problem of the waste utilization became an important thing. An obligation to the waste dispose Poland is introduced on 27 April 2001 on Waste with later changes. Also membership in the UE imposes such an obligation. In the paper the analysis of the amount of metallurgical wastes generated in the production of pig iron was conducted. This data were compared with standards included in reference documents for iron and steel production.

Keywords: Waste, waste management, sustainable development concept

1. INTRODUCTION

The steelwork's task is to produce steel of a certain quality and manufacture certain steel products. During the ongoing technological process, also other products are created, not always wanted, for example waste. In the 1970s and 1980s in Poland, most of this waste was deposited in landfills, constituting an ecological threat. In the face of these dangers, it is worth developing devices and technologies to manage this waste [1-7]. For this purpose, both in the world and in the national blast furnace industry there is a tendency to reuse cheaper "waste" fuels and materials as replacements for a part of blast furnace coke and iron-bearing materials, as well as the use of blast furnace gas energy. There are needed these which are in line with the principles of environmental loading consistent with the Directive of the Council of the European Union 96/61/EU commonly referred to as the IPPC Directive and techniques that prevent or reduce pollution. The description of these techniques is included in the reference documents (BREFs), indicating the Best Available Techniques (BAT), among others for blast furnaces, and developed by Technical Working Groups at the European IPPC Office [7,8].

In the steelworks with full production cycle, where production begins in the ore processing department, then smelting the pig iron and its further processing in steelmaking processes, the waste diversity is greater than in the smelter melting scrap in electric furnaces. In the steelworks producing products from a "extraneous" steel material this diversity is even smaller [2].

By-products from the blast furnace smelting process are:

- slags,
- blast furnace gas,
- blast furnace sludge,
- blast furnace dust.

2. WASTES FROM THE BLAST FURNACE DEPARTMENR OF A SELECTED METALURGICAL PLANT INPOLAND

On the basis of the obtained data from one of the Polish steelworks, the quantity of produced slag and blast furnace gas from two blast furnaces of similar capacity in three subsequent years (marked as 1, 2, 3) was analyzed. In **Figure 1**, the amount of blast-furnace iron produced in the analyzed years from two blast furnaces (marked as 2 and 3) was presented.

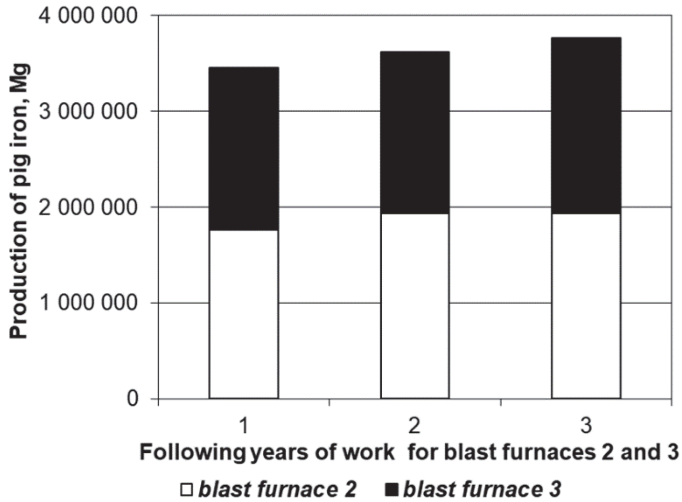

Figure 1 Production of pig iron for three consecutive years from two blast furnaces [own study]

Based on the analysis of the work data of the furnaces 2 and 3, it was found that the production of pig iron in the analyzed period was about 6% higher compared to the previous year, with the average annual production of this period at the level of approx. 3.65 million Mg. This annual increase in production is caused by the increase in demand for this product in Poland and abroad.

In **Figures 2 and 3**, the amount of produced slag and blast furnace gas from the blast furnaces 2 and 3 in three subsequent years was presented.

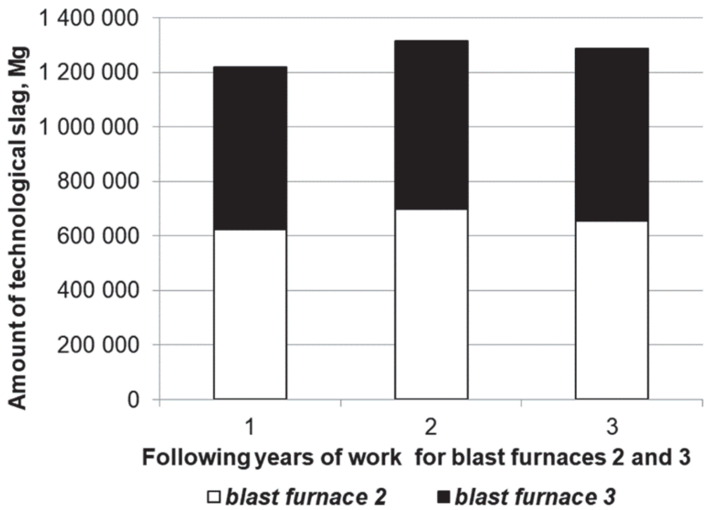

Figure 2 Amount of slag from the blast furnace process for three consecutive years from two blast furnaces (No 2 and 3) [own study]

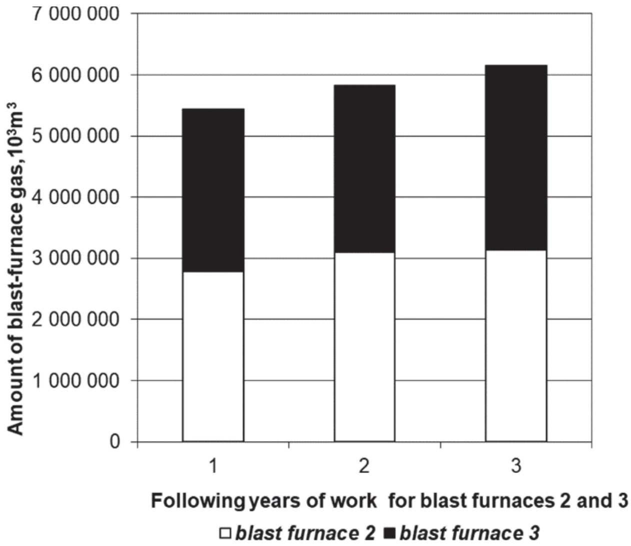

Figure 3 Amount of blast furnace gas from the blast-furnace process for three consecutive years from two blast furnaces (No 2 and 3) [own study]

Analyzing the amount of technological slag produced in two subsequent years, it was found that 95% was granulated slag, 5% was piece slag, while in the third year analyzed the granulated slag accounted for 100%. The granulated slag was sold to the cement plant, where it was used for cement production. The metal pig iron with piece slag was used as own scrap, used during the smelting of steel in converters. The produced blast furnace gas was fully developed at the plant: 47% was used to heat the blast furnace heaters, 57% in other technological processes.

During the blast furnace process, dust and sludge recovery was carried out during gas dedusting (**Figures 4 and 5**).

The collected dust originated from pre-dedusting of input materials (83 - 92%) and taken from a static dust collector as initial dedusting of off-gases (8 - 17%). In addition, final (water) purification of waste gases was carried out, resulting in blast furnace sludge.

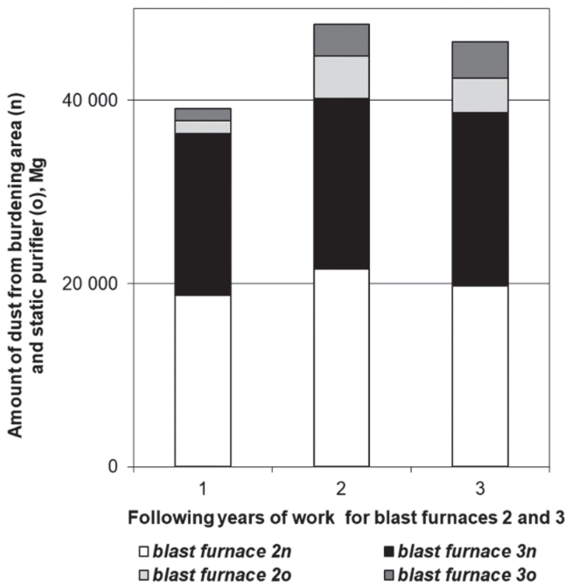

Figure 4 Amount of dust from burdening area (n) and static purifier (o) for three consecutive years from two blast furnaces (No 2 and 3) [own study]

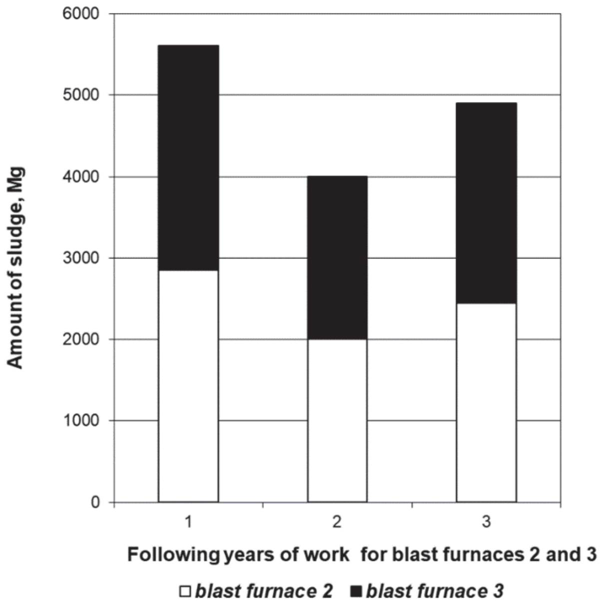

Figure 5 Amount of sludge for three consecutive years from two blast furnaces (No 2 and 3) [own study]

Average chemical composition of dusts and sludge from the blast-furnace process, which was generated in the research period in the steelwork, was presented in **Table 1**.

Table 1 Average chemical composition of dusts and sludge from the blast-furnace process (% mass) [own study]

	Fe	FeO	Zn	S	C	Pb
Dust	48.61	9.76	2.68	0	3.02	0.05
Sludge	15.37	4.17	14.53	1.99	36.91	1.69

Analyzing the chemical composition of dust and sludge, it was noticed that it is a material rich in iron (including iron oxides). It can, therefore, be a input material for the blast furnace process. Blast furnace dusts are entirely managed in the ore sinter plant. On the other hand, it is difficult to develop blast furnace sludge, due to its high hydration, and above all the chemical composition (a large amount of zinc and lead). One of the methods of blast furnace sludge management is its hydrocyclonation (de-zinc treatment). This method is considered the Best Available Technique BREF).

In addition, the amount of sows formed during the blast-furnace process was analyzed in three consecutive years. These sows are developed on the smelter site, used as input materials for technological processes (**Figure 6**).

In case of technology of iron pig production, in the reference documents (BREF) acceptable levels of produced waste materials were recorded: slag, dust and sludge (**Table 2**).

Table 2 Comparison of blast-furnace slag, dusts, sludge production indexes in Poland and according to the BREF [3]

	Amount of waste generated in Polish steelworks	Permissible amount of generated waste according to BREF	Unit
Dust	2.4 - 8.3	6 - 16	kg/Mg of pig iron
Sludge	1.0 - 14	3 - 5	kg/Mg of pig iron
Slag	200 - 360	200 - 290	kg/Mg of pig iron

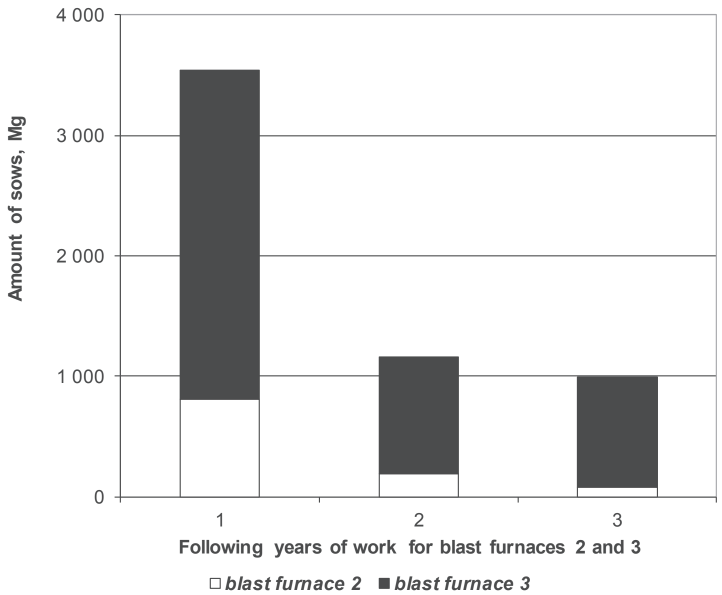

Figure 6 Amount of sows for three consecutive years from two blast furnaces (No 2 and 3) [own study]

The slag production index was compared to 1 Mg of pig iron produced in the following three years (**Figure 7**). In the analyzed period, this index ranged from 342 kg / Mg of pig iron to 364 kg / Mg of pig iron. The obtained data show that in the examined plant, this index increased in relation to the BREF index (on average 290 kg / Mg of pig iron) from 117% to 125%.

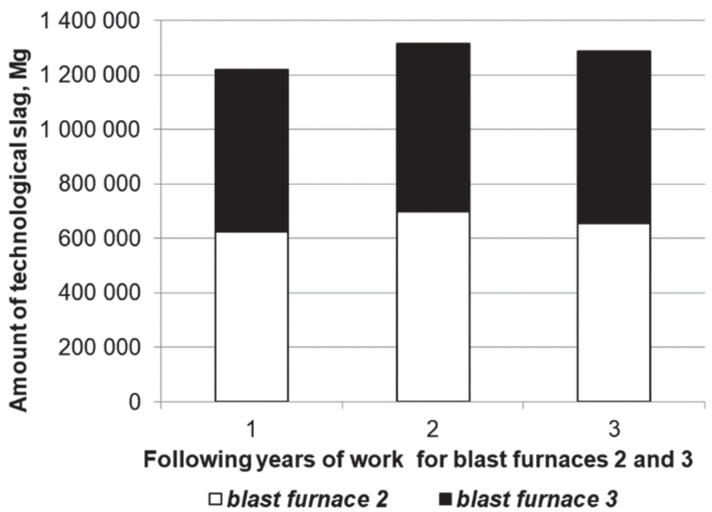

Figure 7 Comparison of blast-furnace slag production index for 1 Mg produced pig iron in relation to the standards according to the BREF for three consecutive years from two blast furnaces (No 2 and 3) [own study]

On the other hand, for dusts and sludge, these indexes were lower than the BREF standards for the generated dusts (**Figure 8**) and sludge generated during the production of pig iron (**Figure 9**).

At the same time, when analyzing the amount of dust and sludge produced per 1 Mg of pig iron produced in a selected metallurgical plant, it was noted that they do not exceed the permissible values according to Polish standards (**Table 2**).

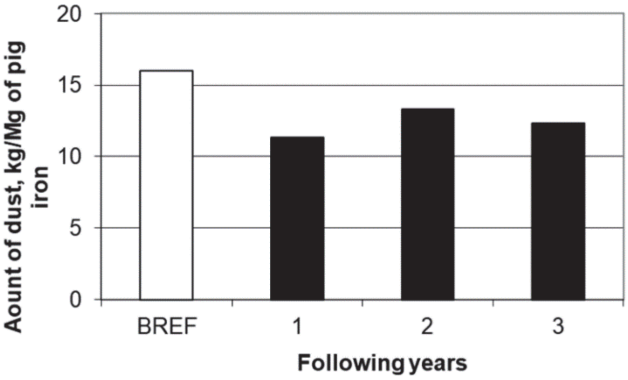

Figure 8 Comparison of dusts production index for 1 Mg produced pig iron in relation to the standards according to the BREF for three consecutive years from two blast furnaces (No 2 and 3) [own study]

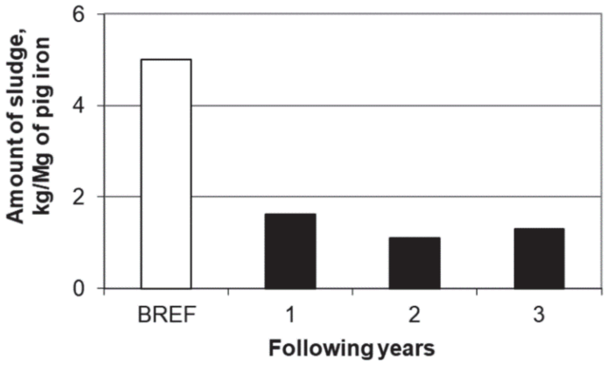

Figure 9 Comparison of sludge production index for 1 Mg produced pig iron in relation to the standards according to the BREF for three consecutive years from two blast furnaces (No 2 and 3) [own study]

3. CONCLUSION

Some of the Best Available Techniques (BAT) for blast furnaces are a reference point that facilitates the assessment of current results achieved at a selected metallurgical plant. Reducing the nuisance for the natural environment by the plants is one of the main aspects of Cleaner Production and the so-called "Additional economic effect" (utilization of waste). This means that the used technology can be considered Cleaner Production and can bring significant benefits to both nature and the enterprise. The methods of waste utilization, which were presented in the paper, recommended in relevant European documents are convergent with the most important objectives included in the operations of this enterprise. This goal, apart from the ability of the steelworks to compete on the European and global markets, is to reduce the negative impact of the plant on the natural environment.

At the same time, the use of waste generated in the plant as input materials for production processes contributes to the protection of natural materials and the protection of the natural environment of man.

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