ACTA TEHNICA CORVINIENSIS – Bulletin of Engineering
Tome VIII [2015] Fascicule 4 [October – December]
ISSN: 2067 – 3809

[1.] Victor ANDREI, [2.] Cristian DOBRESCU,
[3.] Nicolae CONSTANTIN, [4.] Bogdan FLOREA

THE APPLICATION OF STATISTICAL AND MATHEMATICAL METHODS OF ANALYSIS TO REAL DATA PROCESSING OPERATION OF A BLAST FURNACE

[1-4.] Politehnica University of Bucharest, ROMANIA

Abstract: The data collected for the analysis come from the F5 blast furnace from ARCELOR MITTAL Galati, are representative for a period of 30 days, in which he worked and furnace with coal powder injection on at the mouth of windy, to replace a quantity of metallurgical coke, fuel expensive and deficient. In this paper presents a model for application of statistical and mathematical processing real data of a blast furnace, the centralization of data, statistical and mathematical processing, trace correlation diagrams of the main process parameters and functions of significant performance, interpretation of the results.
Keywords: consumption coke, correlation, blast furnace, cast iron

INTRODUCTION

The data collected for the analysis come from the F5 blast furnace from ARCELOR MITTAL Galati, are representative for a period of 30 days, in which he worked and furnace with coal powder injection on at the mouth of windy, to replace a quantity of metallurgical coke, fuel expensive and deficient.

EXPERIMENTAL

For interpretation of results obtained from real data processing operation of a blast furnace from ARCELOR MITTAL Galati, have been used in mathematics and statistical methods of modern data processing.

RESULTS

The objective functions of the correlations were analyzed elected those technological indicators that have a connection and a significant implication on leveraging process iron in blast furnace [1,2,3], namely: daily production of pig iron; daily consumption of coke; specific consumption of fuel equivalent of physical technical; coke pulverized coal methane gas; coke-specific consumption; the yield of carbon dioxide in the gas furnace.

Technological parameters that have a notable influence on the performance of these functions and whose correlation with trial functions have been carried out and plotted were:

- the percentage of crowded, iron
- flow zone of air introduced into the furnace through the mouths of wind
- dust daily consumption of coal used as a substitute for coke,
- specific consumption slacking,-air temperature in a furnace, instilled
- content pig iron Silicon
- simply and complex basicity of ferrous sinter.

Table 1. Results obtained from real data processing operation of a blast furnace from ARCELOR MITTAL Galati

Dust coal comsumption kg/day	Technical coke consumption, kg/tpig iron	Daily production of pig iron t/day	Dust coal specifical consumption kg/tpig iron	Specific consumption of equivalent fuel kg/tpig iron
0	534	2392	0	534
64633	507	3469	18.6315941	525.6315941
25644	537	3151	8.13836877	545.1383688
318210	476	4347	73.2022084	549.2022084
367291	474	4490	81.8020044	555.8020045
368365	488	4658	79.0822241	567.0822241
354711	488	4600	77.1110869	565.111087
377001	496	4491	83.9458917	579.9458918
346822	478	4300	80.6562790	558.6562791
341380	487	4116	82.9397473	569.9397473
160856	544	3868	41.5863495	585.5863495
320664	472	4556	70.3827919	542.3827919
365907	469	4639	78.8762664	547.8762664
363706	456	4547	79.9881240	535.988124
366193	456	4663	78.531632	534.531632
361724	450	4609	78.4821002	528.4821002
365034	450	4701	77.6502871	527.6502872
367805	451	4589	80.1492699	531.14927
366306	451	4568	80.1895796	531.1895797
370388	469	4391	84.3516283	553.3516283
369281	442	4508	81.9168145	523.9168146
374979	445	4688	79.9869880	524.9869881
6716900	15145	128450	1497.60123	16642.60124
216674.1935	488.54838	4143.548	48.3097173	536.8581044

Correlation charts, results are presented in figures 1-11 shown in R^2 values appearing on each chart between 0.20 and 0.9441 (which means the values of the coefficients occurring between 0,45 and confidence 0.99) that all the correlations can be admitted.

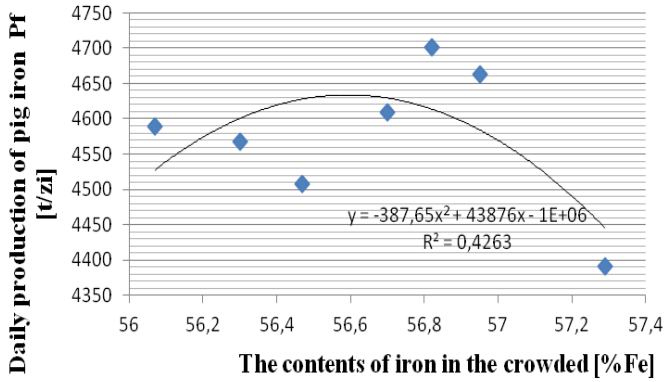

***Figure 1**. Correlation between daily production of pig iron and iron content of the crowded*

From the diagram presented in Figure 1 it is observed that an increase of the content of iron in crowded close to the optimal value of 56.6% leads to an increase in production of cast iron, because the same yield iron crossing of cargo in cast iron, a greater amount of iron in the blast furnace generates a greater amount of cast iron.

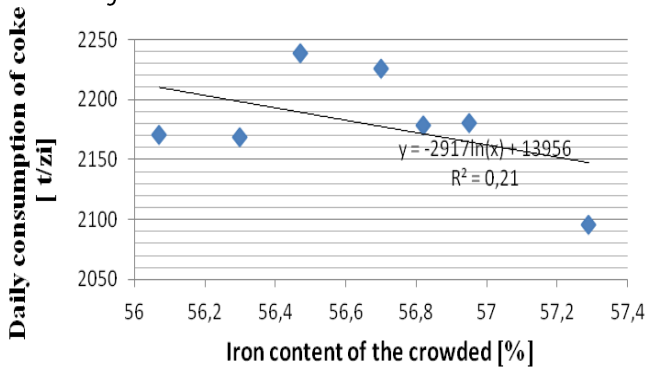

***Figure 2**. Correlation between daily consumption of coke and iron content of the crowded*

In the diagram presented in Figure 2, an increase of the content of iron in the crowded lead to a decrease in the daily consumption of coke, which is beneficial, but decreased conținutui of coke is better motivated by improving the Reducibility of indicators aglomeratului and its permeability.

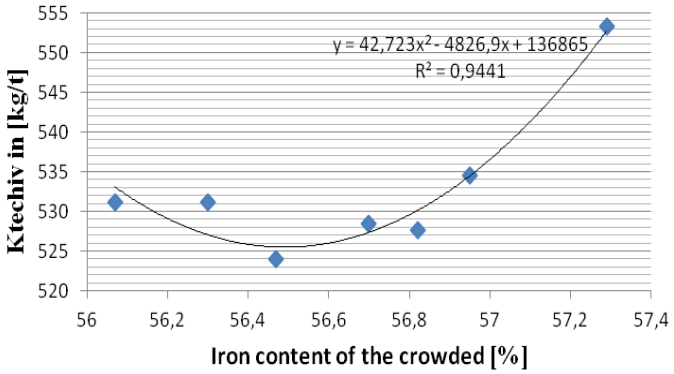

***Figure 3**. Correlation between daily consumption of fuel equivalent and the content of iron in crowded*

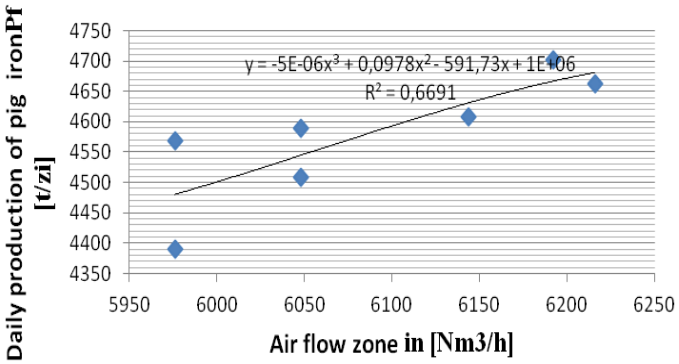

***Figure 4**. Correlation between daily production of cast iron and air flow zone*

In the diagram presented in Figure 3, an increasing content of iron in crowded at about 56%, has a favorable influence on consumption of fuel equivalent.

In the diagram presented in Figure 4, it is observed that an increase in air flow zone leads to increased production of pig iron, which is fully in line with the theoretical and technological logic because the air flow in the blast furnace is the engine of the furnace process.

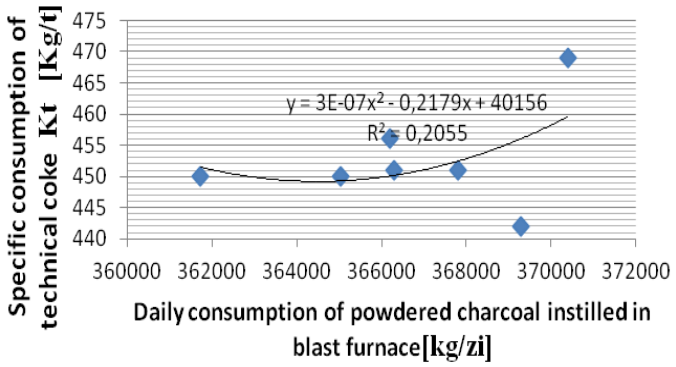

***Figure 5.** Correlation between the specific coke consumption technical Kt and daily consumption of powdered instilled in blast furnace*

In the diagram presented in Figure 5, it is observed that an increasing amount of slacking introduced daily until approx. 36400 kg/day has a favourable influence on the efficiency of process furnace in specific consumption downside of Coke.

In the diagram presented in Figure 6, it is observed that an increase in consumption of coal powder introduced in a furnace has a favourable influence on the efficiency of process furnace in specific consumption downside of Coke, since the aim of the introduction of dust coal fuel auxiliary role is just to replace a quantity of Coke.

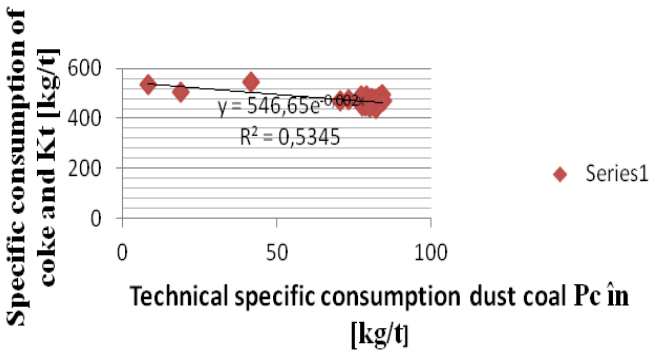

***Figure 6.** Correlation between the specific coke consumption Kt and technical specific consumption dust coal Pc*

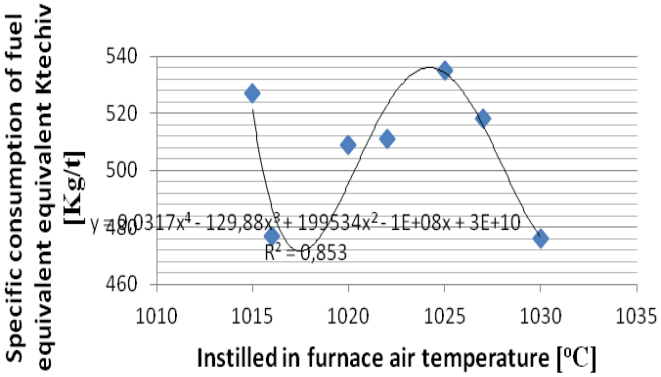

Figure 7. *Correlation between the specific consumption of fuel equivalent Ktechiv and instilled in furnace air temperature*

In the diagram presented in Figure 7, is observed that an increase in air temperature in the furnace up to a value of about 1018°C on the specific consumption of coke and specific consumption of fuel equivalent, what is explained by bringing a additional intake of heat due to air enthalpy, leads to a refilling of a quantity of heat which would derive from the combustion of a carbon amounts entered in a furnace with Coke, leading to lower consumption of coke or fuel equivalent.

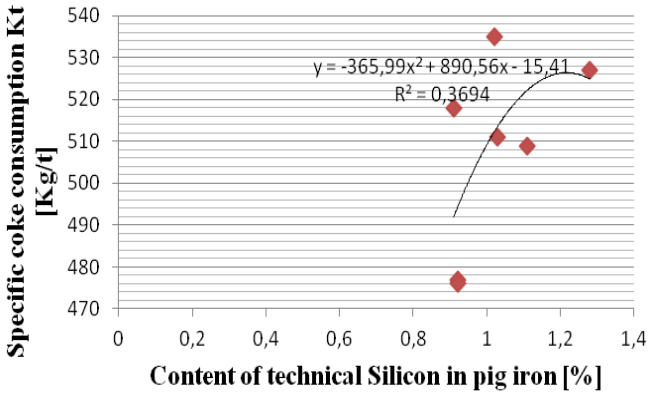

Figure 8. *Correlation between the specific coke consumption Kt and content of technical Silicon in pig iron*

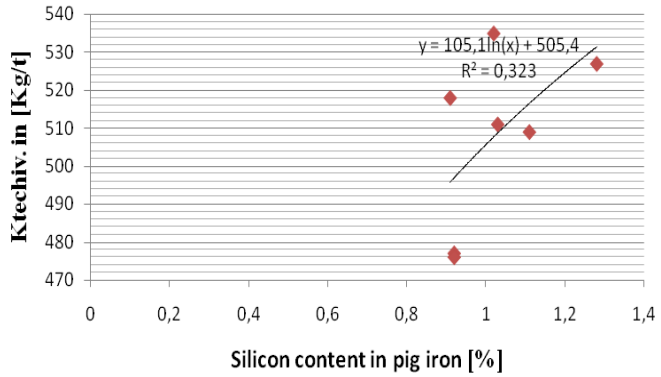

Figure 9. *Correlation between the specific consumption of fuel equivalent (coke + Kt technical slacking Pc) and Silicon content in pig iron*

In the diagrams presented in Figure 8 and 9 it is observed that an increasing percentage of the amount of Silicon in cast iron raises specific consumption of coke and fuel equivalent, which is explained by the fact that getting in Silicon cast iron is made from a strong endoterme reactions, who needs heat what can be ensured only by a greater amount of carbon in the load, retrieved from fuel, so a larger amount of fuel.

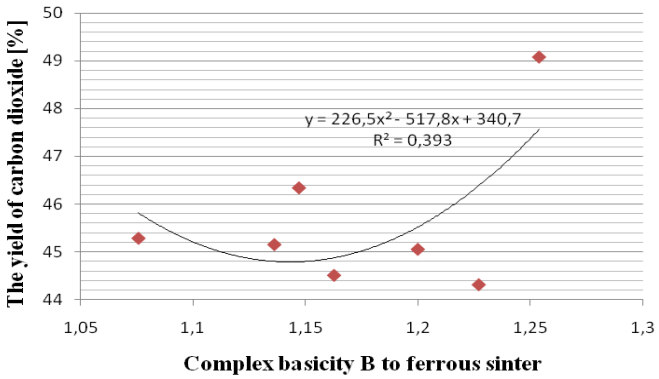

Figure 10. *Correlation between the yield of carbon dioxide in the gas furnace and complex bazicity B to ferrous sinter*

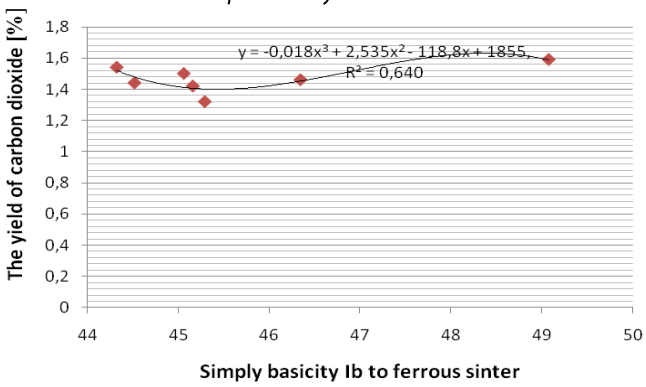

Figure 11. *Correlation between the yield of carbon dioxide in the gas furnace and simply bazicity Ib to ferrous sinter*

In the diagrams presented in Figure 10 and 11, argue it is noted that the value of the sinter ferrous basicity B over 1,15 or a simple basicity Ib over 46 leads to an increase in the efficiency of carbon dioxide in the gas furnace, which means a process of blast-furnace efficiency through effective use of the potential of reducing the gases inside the furnace, which means an increase in the share of indirect reductions with carbon oxide in a furnace and a decrease in the share of direct discounts and a decrease in the specific consumption of fuel to the furnace.

CONCLUSIONS

The analysis of correlation diagrams of the main factors and functions of performance of the process you can deduce the value ranges of variation factors of influence so that for performance functions to obtain the optimal technological values.

The conclusions drawn from the analysis of technological parameters and process functions derived from the calculation of the balance of materials and energy [4,5] to getting the first fusion iron furnace in F5 from Galati in the reporting period are as follows:

- *Load furnace was of good quality, consisting of crowded, pellets and Brazil ore with high content of Fe. Basicity index has remained constant (almost 1).*
- *Blast furnace operation was characterized by a number of stops (small repairs, a low number of hours of work (lack of raw materials, less intensive operation of converters)), which led to a value of index use of time of the order of 95-97%. Under the conditions shown, utilization of production capacity of blast furnace no. 5 ARCELOR MITTAL Galati was 80-85%.*

- *Of technological calculations made on the basis of oxides reduction processes of Fe took place in favourable conditions due to the fact that the operation of the blast furnace was not forced, size of sinteri and pellets loaded and good quality of the value in use (in terms of resistance and size). $\eta_{CO} = 53$ %, comparable to what η was achieved a yield of carbon monoxide is accomplished at blast furnaces with very good indicators.*

Acknowledgement:

This work is supported by the Sectoral Operational Programme Human Resources Development (SOP HRD), financed from the European Social Fund and the Romanian Government under the POSDRU 2014/ Cod Contract: 134398.

REFERENCES

[1.]Nicolae CONSTANTIN, V. Geantă, D. Bunea, R. Şaban: "Metode analitice şi grafice pentru determinarea rapidă a consumurilor de cocs la furnale în cazul utilizării diverşilor combustibili auxiliari." - revista Metalurgia, nr. 9 - 12, 1990, pag 444-448, ISSN 0461-9579

[2.]Nicolae CONSTANTIN, V. Geantă, R. Şaban, D. Bunea: "Stabilireaprin modelare matematică a consumului teoretic optim de cocs la furnale, în funcție de componența încărcăturii."- revista Metalurgia, nr. 6, 1991, pag14-17, ISSN 0461-9579

[3.]Nicolae CONSTANTIN, Diana Ioniță, Augustin Semenescu, Cristian Viorel Semenescu „Metode analitice pentru eficientizarea elaborării fontei în furnal prin corelare aoptimă a consumului de cocs cu parametrii de suflare la gurile de vânt" – revista Metalurgia, nr.6, 2003, pag. 5-12, ISSN 0461-9579

[4.]Nicolae CONSTANTIN, Diana Ioniță, Augustin Semenescu, Cristian Viorel Semenescu, Mircea Costache „Eficientizarea producerii fontei de prima fuziune prin conducerea asistata de calculator a procesului de elaborare a fontei în furnal. Partea I-a. Realizarea modelului matematic de conducere asistata de calculator a procesului de elaborare a fontei în furnal. Realizarea aplicatiei software "calcul furnal", revista Metalurgia, nr. 7, 2003, pag. 17-28, ISSN 0461-9579

ACTA Technica CORVINIENSIS
BULLETIN OF ENGINEERING

ISSN:2067-3809