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RESEARCH ON THE POSSIBILITIES OF IMPROVING THE PRODUCTIN OF CAST IRON IN THE FIRST MERGER BY IMPROVING FLOW GAS PHASE IN THE BLAST FURNACE

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ABSTRACT: *Because the cast iron-making blast furnace is a complex process of mass and energy transfer between solid and gas phase with reduced character, improving operating parameters can be achieved by improving gas flow in the blast furnace. Obtaining an optimal permeability of the column of materials allow optimum circulation of a gaseous phase, using its entire reducing potential. It is thus possible to increase utilization efficiency of useful volume thus increasing productivity. This paper aims to study the permeability of different mixtures which can form the blast furnace load and propose optimal ratio between their weights.*
KEYWORDS: *blast furnace, optimal permeability, mass and energy transfer*

INTRODUCTION

Many research works as well as the practical operation of the blast furnaces have shown close correlation between the regime of operation of furnace and gas flow through solid materials in the tank column.

Thus the conclusion reached that gas can flow through the furnace in unit time through unit area of section, substantially influence the blast furnace productivity.

The blast furnace productivity decreases proportionally with increasing unevenness degree in the flow of gas, also an increase in specific consumption of coke due to improper use the reduction character of gaseous phase.

So it can't achieve an economic function of blast furnace without achieving optimal distribution of gas tank and consequently good contact of phases which are entering in reaction physics-chemical processes occurring in the blast furnace.

This favorable distribution of gases can be achieved by measures taken at the charge part of the blast furnace (the unit load size, the load schedule, the load level).

METHODOLOGY

In a column of infinite load as expanse volumes it can obtain a uniform distribution of the gases regardless of the size filling bodies particles. Instead in a limited load column as dimensions, the gases flowing depends on the ratio between (d) diameter of granules that are forming the load and (D) diameter of column, at high values of ratio d / D ascertaining a powerful peripheral gas circulation due to the higher value of the voids volume near the column walls.

But in a blast furnace, the flow of gas is influenced by the movement of cargo particles which facilitates the appearance of free spaces between these.

The tendency to form free spaces is larger to loads composed by large irregularly shaped pieces. From geometrical a reason at the spherical particles is accomplished the best possibility of charge particles movement.

In terms of the reduction process, small pieces behave better. Therefore it is seen mostly a better performance of the blast furnace when the pieces of agglomerate ores are smaller or when using pellets.

This leads on the one hand to a better performance of the blast furnace due to the gases uniform distribution on section by free spaces uniformly distributed without preferred corridors, but also may lead to a higher pressure loss to the equal flow of gases which are crossing the blast furnace because the pressure loss increases with decreasing of the particles diameter

The pressure loss per unit length depends on the gas flow speeds, the physical characteristics of these, the shape, the size and the settlement method of the filling bodies.

For dimensionless representation of the pressure loss it is used the relation between the dimensionless resistance coefficient ψ and Reynolds number: ψ = f (Re)

These two indices have been defined by M. Brauer as follows:

$$\Psi = \frac{\varepsilon^3}{1-\varepsilon} \cdot \frac{d}{\rho w^2} \cdot \frac{\Delta p}{H}, \quad \text{and} \quad Re = \frac{1}{1-\varepsilon} \cdot \frac{w \cdot d}{v}$$

where: ε- the goals factor in the column load; d- the diameter of filling bodies [m]; ρ- the gases density that flows through the load [kg/m^3]; ν- the kinematic viscosity of gases [m^2/s]; w- the speed of gases flow in the empty column [m/s]; H- the height column of load [m];

The loss of pressure has already been measured in a variety of materials. Most researches have been limited to the monogranulare materials and only few bigranulare materials such as the type of materials introduced into the blast furnace.

ANALYSES/ RESULTS

This paper aims to present the results and conclusions drawn for experiments with components materials of blast furnaces load from Romania.

The experiments dealt with determining the permeability of columns consisting of coke material, agglomerated, pellets but for comparison term and artificial load consisting by glass beads with diameter close to the pellets.

It has been followed the possibility of obtaining an optimum permeability for a column with similar load to that of cargo tank blast furnace, with the ultimate goal of increasing the intensity of operation by improving the gases flow through the blast furnace tank.

Experiments were conducted in the laboratory of Metallurgy of Cast Iron, Siderurgy Department from University "Politehnica" of Bucharest. The experimental installation is shown schematically in Figure 1.

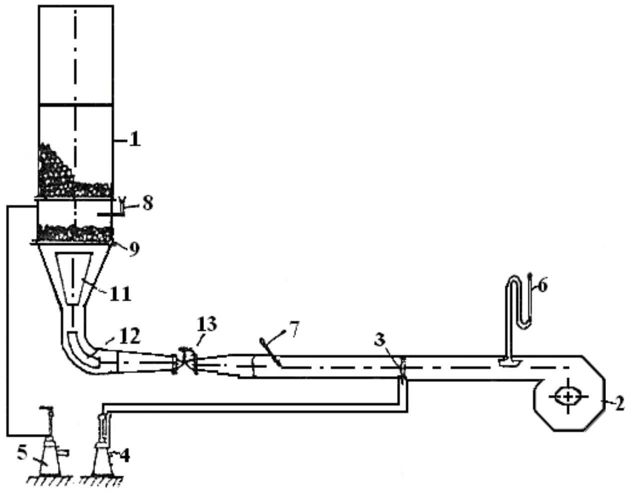

Figure 1. The experimental installation

The installation comprises a cylindrical container (1) with the height of 1.35 m and 0.35 m in diameter, provided at the top with a state gas valve for measuring the gas pressure after it passes through the granular load from the column (2). The cylinder is closed with a conical cap fitted with a gas discharge pipe (3). In the lower area there is a filler cap for draining of installation (4). Under the filling area is another one of pressure equalization (5). It consists of a cylindrical tube provided at both ends with flares of extending and tightens .Here there is a flare connected to measure the gases pressure in the entry of column load (6). The cylinder is fed with gas (air) through a pipe fitted with a valve for regulating the gas flow (7). The flow measurement is made with a measurement diaphragm. (8). Gas supply (air) is made through a motor-blower group.

Table 1.

Exp No	Load	Type of load	Average diameter[m]	Equivalent diameter[m]	Goals coefficient(ε)
1	1/1 balls	layer	0.019	0.019	0.371
2	1/1 pellets	layer	0.012	0.012	0.387
3	1/1 agglomerates	layer	0.03	0.03	0.417
4	1/1 coke	layer	0.04	0.04	0.478
5	1/3 balls+2/3 aggl.	mixture	-	0.022	0.380
6	1/3 balls+2/3 aggl.	layer	0.19/0.03	0.022	0.371/0.417
7	2/3 balls+1/3 aggl.	mixture	-	0.0179	0.378
8	2/3 balls+1/3 aggl.	layer	0.19/0.03	0.0179	0.371/0.417
9	1/3 pellets+2/3 balls	mixture	-	0.0158	0.35
10	1/3 pellets+2/3 balls	layer	0.012/0.019	0.0158	0.387/0.371
11	2/3pellets+1/3 balls	mixture	-	0.0168	0,27
12	2/3pellets+1/3 balls	layer	0.012/0.019	0.0168	0.387/0.371
13	1/3 balls+2/3 coke	mixture	-	0.029	0.40
14	1/3 balls+2/3 coke	layer	0.019/0.04	0.029	0,371/0.478
15	2/3balls+1/3 coke	mixture	-	0.023	0.39
16	1/3 coke+2/3 aggl.	mixture	-	0.0186	0.39
17	1/3 coke+2/3 aggl.	layer	0.045/0.016	0.0186	0.478/0.395
18	1/3 coke+2/3 aggl.	mixture	-	0.0248	0.40
19	1/3 coke+2/3 aggl.	layer	0.04/0.021	0.0248	0.465/0.405

The dependences Δp = f (Qa), y = f(x)

Table 2.

Exp No	Eq Δp=f(Qa)	y_{xy}	The slope of line
1	Y=1.542X-74.10	0.970	57.03
2	Y=1.570x-39.15	0.976	57.50
3	Y=0.887x-39.15	0.966	41.57
4	Y=1.208x-64.21	0.969	50.38
5	Y=1.134x-56.26	0.960	48.59
6	Y=1.035x-52.95	0.965	45.98
7	Y=1.614x-73.78	0.978	58.12
8	Y=1.294x-55.42	0.981	52.30
9	Y=2.188x-80.46	0.975	65.43
10	Y=2.474x-116.84	0.965	67.99
11	Y=2.577x-121.48	0.968	68.79
12	Y=2.010x-85.52	0.969	63.54
13	Y=1.442x-75.012	0.969	55.26
14	Y=1.396x-79.75	0.966	54.38
15	Y=1.596x-75.59	0.969	57.93
16	Y=1.151x-53.03	0.970	41.73
17	Y=0.892x-40.12	0.977	49.01
18	Y=1.027x-50.449	0.951	45.76
19	Y=0.789x-36.97	0.945	38.27

The experimental dates and a series of mathematical results of statistical processing are presented in Tables 1 and 2.

In the table 2 there are presented the linear correlations between pressure loss y=Δp in [mmH_2O] and flow of air blown into the column x=Qa in [m^3/h] of the form y = f (x). For all 19^{th} experiments were drawn simple linear correlations which can be accepted considering the correlation of coefficient values y_{xy} higher than 0.9. Grouping favorable studied cases and drawing lines in the same rectangular coordinates some important conclusions are obtained.

CONCLUSIONS

Among the conclusions of the conducted research can be mentioned:

- *The loads consisting of two granules size with small diameter d_k and large diameter d_g can represent the conditions from modern blast furnaces in which the load basically consists of agglomerates and coke, well grinded and loaded in granulate limits prescribed. In the case of loads formed by granules with two dimensions, the permeability varies according to how the load is made of in distinct layers or homogenous mixtures.*
- *confirming the experiments of Foumas, the coefficient of goals mixture (ε_m) passes through a minimum at about 28-30% large granules in mixture , the values of ε_m decrease in the same time with the diameters ratio d_k/d_g;*
- *it is observed that regardless of the blowing air speed in the column, the pressure loss is greater at homogeneous mixtures than at loads in separate layers;*
- *the value of medium goals coefficient (εm) decreases proportionally with the size difference between the diameters of components (this value is best shown by these experiments (16 and 18);*
- *the coefficient values of goals for monogranular loads are different by the type of material. It can be noticed that at the same mixture of two different diameters the goals coefficient is not the same for different proportion participation of those two types of granules, (exp 9, 11).*
- *looking at the correlations y = f (x) that means Δp = f (Q), presented in Table 2, it can be observed the increase of Δp with Qa for all experimental situations;*
- *for the mixtures made of the same type of granules the increasing of Δp with Qa is more emphasized by the time the increasing of small granules proportion in the load (which is visible following the lines slope α in Table 2;*
- *for the same type of bigranulare loads the increase of Δp with Qa is more emphasized for mixtures than for loads in separate layers;*
- *for the monogranulare loads the increase of Δp with Qa is faster for loads with a smaller coefficient of goals.*

As the gas flow through the furnace load, uniform and without fault in the descending column of material, requires minimal pressure loss, indicates that the upper area of the furnace (the granular area) there are advantageous to use the loads of granules of equal size between them, and the charging to be done in layers, each layer comprising granules of the same diameter.

From the technological point of view regarding the behavior of materials from the blast furnace load and in the other areas of the blast furnace it is necessary the existence of a certain ratio different from the value 1 between agglomerate granulation and of the coke, the value of this ratio being 0.35 to 0.40.

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