ANNALS of Faculty Engineering Hunedoara – International Journal of Engineering
ISSN: 1584 - 2673

RESEARCH AND EXPERIMENTS ON THE CUMULATIVE INFLUENCE OF TECHNOLOGICAL FACTORS ON THE QUALITY OF RAW PELLET

Eugen Mihai CRISAN, Teodor HEPUȚ

Faculty of Engineering of Hunedoara, ROMANIA

ABSTRACT
Pellet process need to be studied because the very fine grain iron concentrates cause particular difficulties in the crowded lane, and because the process allows the recycling of waste in very good conditions resulting ferrous powder metallurgical processes.
Pellet to increase capacity are added to ore binders such as bentonite, lime and some salt such as soda or sulphate of iron, the most common binder is bentonite.
In the research were made using pellets as raw material powder containing iron waste and waste containing metallic oxides and MgO hydrogencarbonate., Pellet production aimed to determine the influence of technological factors on the compressive strength of pellets. Research data results were processed by MATLAB computer program results are presented in graphical and analytical form.
Keywords
Pellets, grain, binder, fraction size, compressive strength

1. INTRODUCTION

Among the factors that prompted the routine use of pellet furnaces in charge mentioned first need to exploit iron ore deposits which are subject of concentrations previously. Fine-grained iron concentrates causing difficulty in the crowded lane, the only method that has proven effective in this case is pellet. Also this process allows the best possible recycling of waste powder (steelworks dust, red mud, iron concentrate fly ash).

To increase the capacity of the ore pellet various binders is added in proportion of 0.2 to 2.0%. The most common binder is bentonite. It is also used montmorilonit group clays, lime and some salt (soda or sulphate of iron).

2. EXPERIMENTS IN THE LABORATORY PHASE

Pellets were produced using waste as raw materials containing iron powder and waste containing metallic oxides and MgO hydrogen-carbonate.

Pellet production aims at conducting a research on the influence of technological factors on the quality of raw pellets, defined by compressive strength.

As the influential technological factors to take into account the following: % below 0,040 mm size fractions, %% bentonite and water. Depending on these factors have produced pellets after 108 recipes, 2 batches / recipes from each batch determining the compressive strength of two pellets of raw pellets, taking into account the average values.

Such experiments have needed a huge workload, especially for pellet production and characterization. In this respect, and resistance to compression experiments were conducted by a team of four students, three of them chasing each factor influence a particular technology (from those presented above), and in this paper is presented the cumulative impact of these factors.

Pellet production, as the above technology we used in laboratory pellet plant Energy and raw material base within the Department of Engineering and Management – Faculty of Engineering of Hunedoara.

Pellets were produced by recipes below. Determination of compressive strength was at the Materials Analysis Laboratory Research Center Alba Refractory Products. The data were processed using modern technical computing.

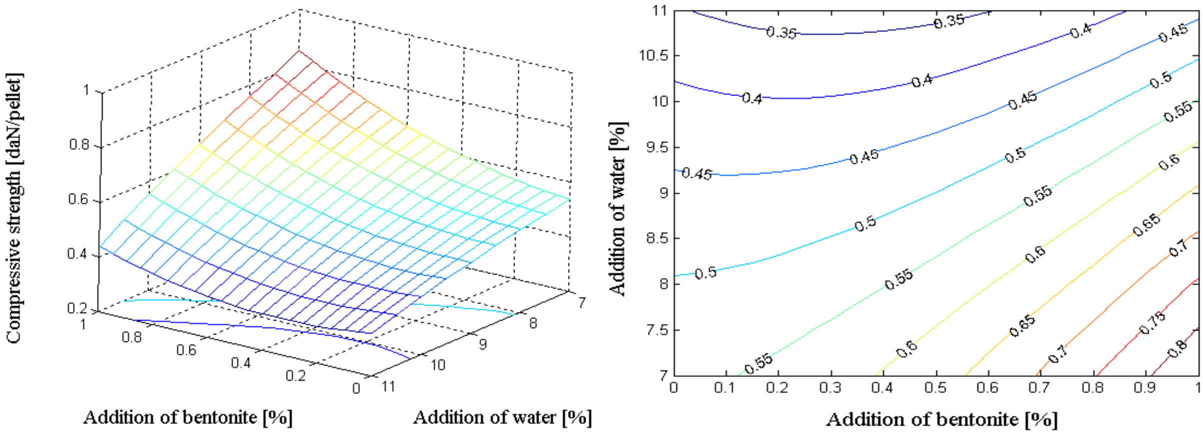
Table 1. Composition recipes

Number of recipe		% fraction under	Composition recipes,%						% water
			P.OSM[1*]	P.OE[2*]	Ş.AF3[*]	Ş.T4[*]	NR[5*]	Bentonite	
1	RA.	43,4	15	54-55	10	10	10	0-1	7-11
2	RB	67,2	15	54-55	10	10	10	0-1	7-11
3	RC	94,0	15	54-55	10	10	10	0-1	7-11
4	RD	99.0	15	54-55	10	10	10	0-1	7-11

[1*] Siemens-Martin steel plant dust (OSM-II) ; [2*] Electric steelworks dust (OE) ; [3*] Sintering furnaces slam; [4*]Slam; [5*] Red mud; [1*, 2*, 3*,4*] Arcelor-Mittal Hunedoara waste; [5*] Alumina Factory waste Oradea.

3. RESULTS

Of experiments performed both on practical observations (visual), and the determination of resistance to compression, resulting in experiments that use waste can be processed by the proposed recipes. To establish correlation equations between compressive strength of raw pellets according to technological factors of influence, we processed the data in MATLAB computer program and results are presented both analytical and graphical form. Presented in graphical form regression surface, showing either the point of maximum / minimum point, so is the shape of a parabolic or stationary point, so saddle type surface. Also all graphical form for each correlation are presented and horizontal projection of contours, is lines of intersection of the correlation surface with planes parallel to the horizontal plane. Based on contours may cause variation limit independent parameters (influence factors) on the dependent parameter in this case the compressive strength in the raw pellets.

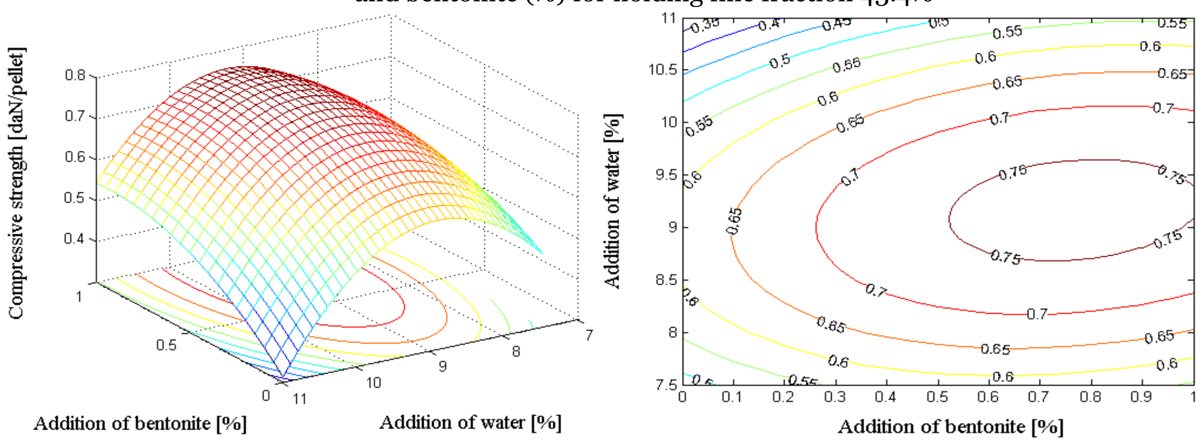


z = b(1) + b(2).*u + b(3).*v + b(4).*u.*v + b(5).*u.^2 + b(6).*v.^2

b = 0.5532 0.4656 0.0255 -0.0564 0.2385 -0.0040

x – addition of bentonite, %; y – addition of water, %; z – compressive strength [daN/pellet]

Figure 1. Compressive strength of raw pellets according to the addition of water (%) and bentonite (%) for holding fine fraction 43.4%

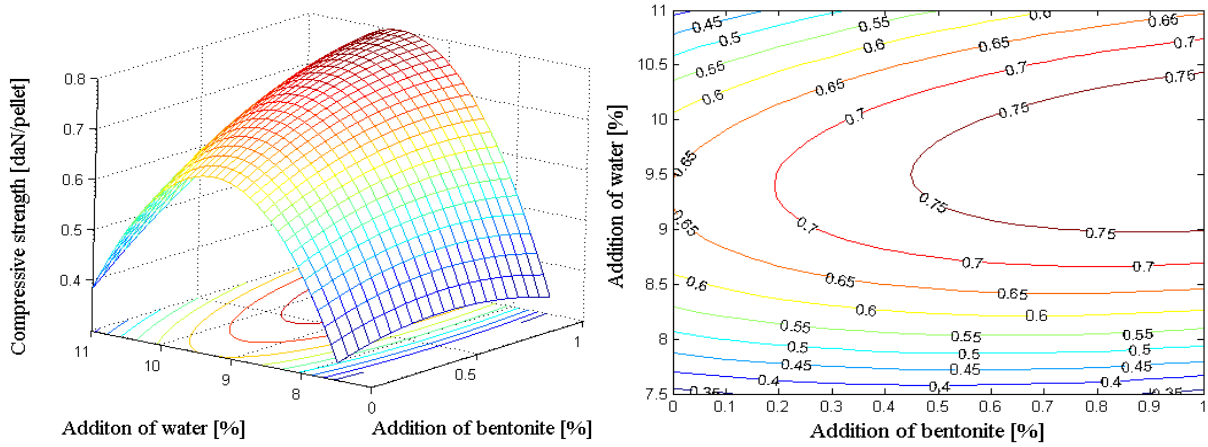


z = b(1) + b(2).*u + b(3).*v + b(4).*u.*v + b(5).*u.^2 + b(6).*v.^2;

b = -4.8154 -0.0210 1.2197 0.0467 -0.2658 -0.0685

x – addition of bentonite; y – addition of water; z – compressive strength [daN/pellet]

Figure 2. Compressive strength of raw pellets according to the addition of water (%) and bentonite (%) for holding fine fraction 67.2%

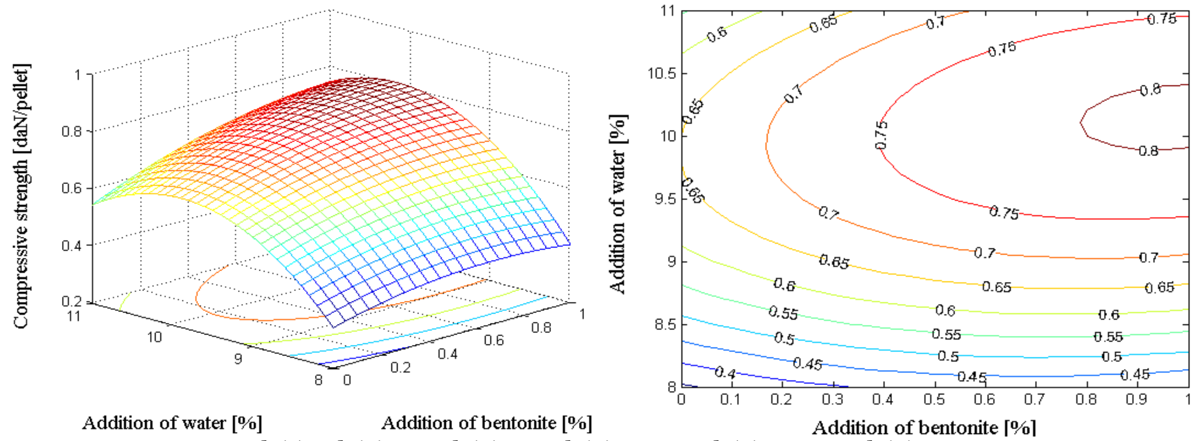


z = b(1) + b(2).*u + b(3).*v + b(4).*u.*v + b(5).*u.^2 + b(6).*v.^2;

b = -7.6210 -0.4093 1.7741 0.0737 -0.1441 -0.0951

x – adaosul de bentonită [%]; y – adaosul de apă [%]; z – compressive strength [daN/pellet];

Figure 3. Compressive strength of raw pellets according to the addition of water (%) and bentonite (%) for the fine fraction of 94% shareholding

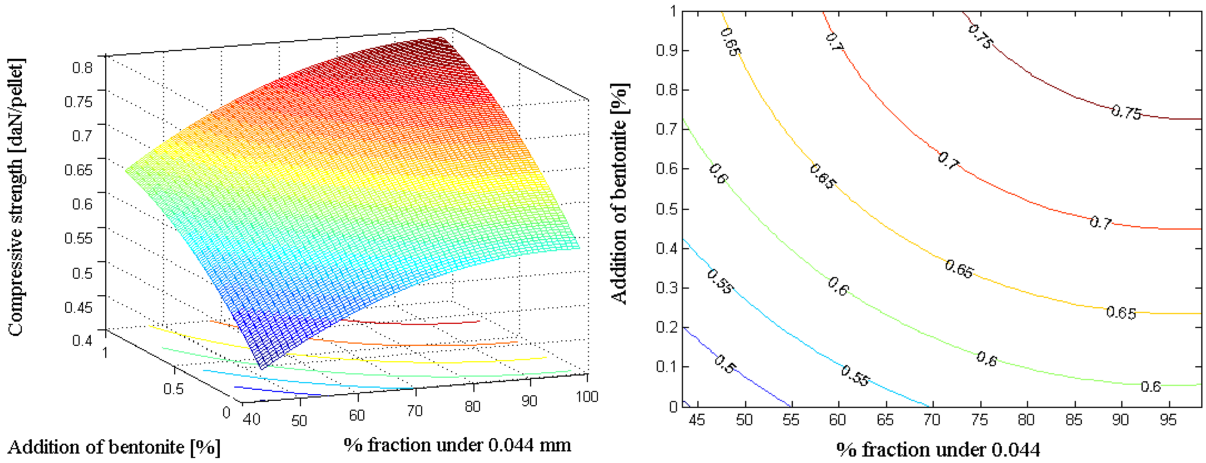


z = b(1) + b(2).*u + b(3).*v + b(4).*u.*v + b(5).*u.^2 + b(6).*v.^2;

b = -7.8340 -0.1396 1.7161 0.0463 -0.1702 -0.0868

x – addition of bentonite[%]; y – addition of water[%]; z – compressive strength [daN/pellet]

Figure 4. Compressive strength of raw pellets according to the addition of water (%) and bentonite (%) for the fine fraction of 99% shareholding

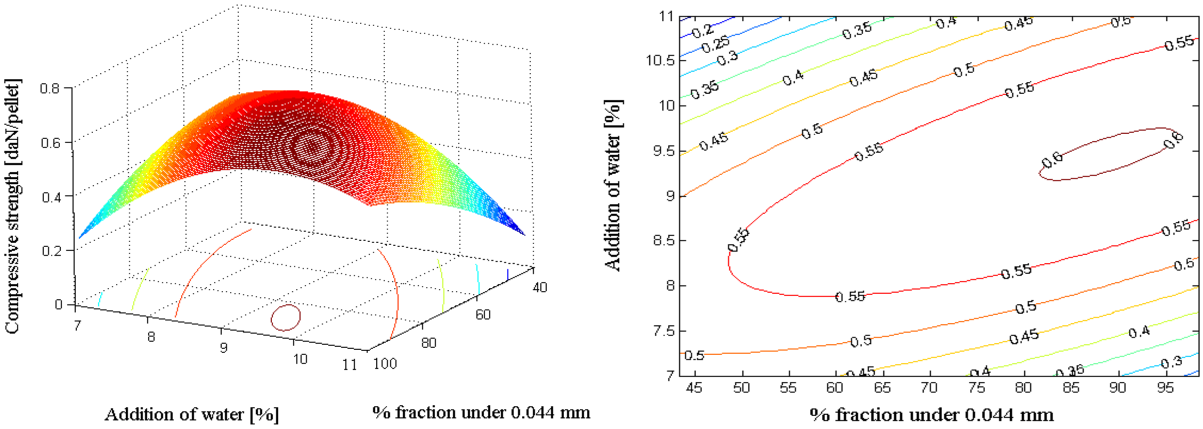


z = b(1) + b(2).*u + b(3).*v + b(4).*u.*v + b(5).*u.^2 + b(6).*v.^2

b = 0.1161 0.0098 0.2782 0.0003 -0.0001 -0.1100

x - % fraction under 0.044 mm; y- addition of bentonite [%]; z – compressive strength [daN/pellet]

Figure 5. Compressive strength of raw pellets according to the addition of bentonite (%) and holding the fine fraction



$$z = b(1) + b(2).*u + b(3).*v + b(4).*u.*v + b(5).*u.^2 + b(6).*v.^2;$$

$$b = -1.8957 \quad -0.0139 \quad 0.6580 \quad 0.0029 \quad -0.0001 \quad -0.0482$$

x - % fraction under 0.044 mm; y- addition of bentonite [%]; z – compressive strength [daN/pellet]

Figure 6. Compressive strength of raw pellets according to the addition of water (%) and holding the fine fraction

4. INTERPRETATION OF RESULTS

In Figures 1-4 the influence of bentonite and water addition on the compressive strength of raw pellets for different stakes in charge of pellet of fine grain material (below 0.040 mm), namely 43.4%, 67.2%, 94% and 99% are shown. Analytical form of these dependencies is in the form of second-degree polynomial equations and graphical form in the form of regression surfaces. For each correlation are presented and correlation surface projection of the horizontal contour.

Presentation of contours in Figure 1 that with increasing addition of bentonite, the water added to the lower values are obtained with the pellet compressive strength to the upper limit over 0.65 daN / pellet.

In small additions of water and bentonite pellets are obtained for compressive strength to low raw pellets, located to the lower (below 0.30 to 0.40 daN / pellet).

Therefore to obtain pellets which take raw good compressive strength when holding charge fine fraction pellet of 43.4%, the addition of water to be 7-8% of bentonite and 0, 5-1%. In this case there is good correlation between the three factors unrelated technology: addition of water, % addition of bentonite, % and holding fine fraction.

Analyzing the data presented in Figure 2, pellet charge for participation in the fine fraction 67.2% is observed the following:

- Contour level curves are closed, so for larger limits of variation to obtain well-defined values of compressive strength;
- To obtain pellet compressive strength of raw than 0.7 daN / pellet, values for additions of bentonite and water should vary so that its values are contained within the boundaries delimited by the curve of 0.7.

The situation is similar to the proportion of fine fraction of 94% and 99% with the observation that the range of variation for values of 0.7 daN / pellet for compressive strength extends to lower margins and higher water bentonite, which explicable in terms of technology by increasing specific surface along with decreasing grain.

In Figure 5 is presented graphically and analytical variation in compressive strength of raw pellets according to the addition of bentonite and the proportion of fine fraction of charge pellet. Can been see from the projection level horizontal curves that with increasing addition of bentonite and the proportion of fine fraction increase values for compressive strength, the value of compressive strength which we want to obtain and proportion of fine fraction in charge of choosing pellet addition of bentonite. For example, to obtain in the case of batches with 90% fine fraction, pellet compressive strength 0.7 daN / addition of bentonite pellets must be at least 0.72%.

Figure 6 is presented in graphical and analytical variation presents the compressive strength of raw pellets according to the addition of water and the proportion of fine fraction of charge pellet. Can be seen from the projection level horizontal curves that with increasing proportion of fine fraction increase values for compressive strength, the value of compressive strength which we want to get, and the proportion of fine fraction of pellet choose batch water addition. For example to get a case of batches with 90% fine fraction, pellet compressive strength 0.55 daN / pellet addition of water must be contained within 8.5 -10.5%.

To get a case of batches with 70% fine fraction, pellet compressive strength 0.55 daN / pellet addition of water must be contained within 8.0 -9.75%.

5. CONCLUSIONS

In conclusion it can be said that processing the computer program MATLAB allows better understanding of factors influencing pellet quality and range of variation of their choice.

As a general conclusion, that proposal can be considered to have worked with the addition of bentonite of 0.75 to 1.0% and 9.5 to 10.5% moisture and fine fraction over 70-80%.

REFERENCES

[1] *Project no. 31-098/2007: Prevention and fighting pollution in the steelmaking, energetic and mining industrial areas through the recycling of small-size and powdery wastes, Program 4 "Parteneriate in domenii prioritare", 2007-2013.*

[2] *Heput, T., Constantin, N., Socalici, A., Ardelean, M., Ardelean, E.: Researches regarding recycling of small-size and powdery ferrous wastes existing in Hunedoara area, Symposium Generation, prevention and processing of pollutant emissions in industrial environment, Bucuresti, 12-13 June 2009.*

[3] *Ardelean, E., Ardelean, M., Socalici, A., Heput, T., Josan, A.: Researches in laboratory phases regarding to capitalization of ferrous pulverous waste in pellets, International Conference of Metallurgy and Materials Science, Bucuresti, 2008.*

[4] *Heput, T., Socalici, A., Ardelean, E., Ardelean, M.: Environment ecological process in Hunedoara area through reinsertion in economic circuit of scrap and pulverous waste, Annals of the Faculty of Engineering Hunedoara - Journal of Engineering, VII(3), pp. 293-298, 2009.*

ANNALS OF FACULTY ENGINEERING HUNEDOARA
– INTERNATIONAL JOURNAL OF ENGINEERING

Faculty of Engineering Hunedoara,
5, Revolutiei, 331128, Hunedoara,
ROMANIA
http://annals.fih.upt.ro