Studies Concerning Physical and Chemical Features of Solid Residues from Metallurgical Industry

Adina Berbecea[*], Aurel Iovi[**], Petru Negrea[**]

[*]Banat's University of Agricultural Sciences Timisoara, Faculty of Agriculture, Calea Aradului nr.119, Timişoara

[**] "Politehnica" University of Timisoara, Faculty of Industrial Chemistry and Environmental Engineering, Piata Victoriei, No.2, 300006 Timisoara, Romania, Phone: ++40256404191, E-Mail: iovi@chem.utt.ro

Abstract: In this paper we studied the possibilities of using slag from metallurgical industry as a source of metals for other industries. Furnace slag and steel slag which result from steel obtaining process on metallurgical process on Resita Metallurgical Plant were analyzed for metal content determination.

Keywords: solid residues, furnace slag, steel slag, metals recovery.

1. Introduction

Considering the fast rhythm of industry development, of deep introducing in our life of modern civilization elements, a major and vital problem is environment protection.

For industrial residues control and preventing air and water pollution, some strictly measures must be taken.

Technical and technological development put mankind into a difficult situation: limitated reserve of row materials, available and exploitable by known technologies. For exceeding these crises, it comes out some directions:

- reconsidering sources of raw materials based on improvement of conventional extraction technologies;
- settle of new technologies, who make exploitable some omitted resources till now;
- discovery new resources;
- reintroducing reusing materials in economical circle.

Cations from solid residues of metallurgical industry could be recovered in salts form and reintroduced in technological processes, which use this kind of raw materials [1-7].

2. Experimental

During separation of impurities from melt steel in furnace, result slag. Slag is a liquid melt, a complex solution of oxides and silicates, which solidify at cooling.

Slag composition vary, depending of obtained steel type [5, 9].

For studying the possibilities of metals recovery from slag, in lab experiences, we determinate the physical and chemical features of two types of slag:

- furnace slag, which result in pig steel obtaining process,
- steel slag, which result in steel obtaining process, in Siemens-Martin furnaces.

For metals content determination, slag was put into acid mineralization, into a mixture of 32% HCl and 54% HNO_3 (20:1 volume ratio).

Metals content was determinated by

- flame emission spectrophoto-metry method, for Na and K, in the following conditions:

TABLE 1. Na and K determination by flame emission spectrophotometry method

Parametrs	Metal	
	Na	K
Flame type	Air - acetylene	Air - acetylene
Wave lenght λ (nm)	589	766.5
Slit depth (nm)	0.2	0.7

- atomic absorption spectro-photometry method for Ca, Mg, Fe şi Mn, in following conditions:
- Ca – flame type: air - acetylene; air flow: 10 L/min; acetylene flow: 1.5 L/min; lamp current: 14 mA; wave lenght λ = 422.7 nm; slit depth: 0.5nm;
- Mg – flame type: air - acetylene; air flow: 10 L/min; acetylene flow: 2 L/min; lamp curernt: 5 mA; wave lenght λ = 202.6 nm; slit depth: 1 nm;
- Fe – flame type: air - acetylene; air flow: 3.5 L/min; acetylene flow: 1.5 L/min; lamp current: 5 mA; wave lenght λ = 392 nm; slit depth: 0.2 nm;
- Mn – flame type: air - acetylene; air flow: 3.5 L/min; acetylene flow: 1.5 L/min; current lamp: 3 mA; wave lenght λ = 279.5 nm; slit depth: 0.2 nm [10-13];

3. Results and discussion

Physical and chemical features of furnace slag and steel slag, used in lab experiences, are presented in Table 2 and Table 3.

TABLE 2. Physical characteristic of raw materials

Slag type	Agregation state	Appearance	Colour
Furnace slag	solid state	dust	white - grey
Steel slag	solid state	cassant mater	black - green

From dates above results that furnace slag is a dust, and steel slag is a cassant matter, a mixture of particles with different granulation. After sorting, we obtained few fractions, prezented in table 3.

TABLE 3. Granulometric composition of steel slag

Fraction	Content (%)
F_1 (> 1,25 mm)	24.74
F_2 (> 800 µm)	1.22
F_3 (> 400 µm)	6.11
F_4 (> 250 µm)	8.34
F_5 (> 90 µm)	25.19
F_6 (< 90 µm)	34.37

In experimental researches for mettals recovery from steel slag, we used the following fractions: F_5 (90÷250µm) and F_6 (<90µm).

Sample of furnace slag and stell slag were analyzed by dezagregation, followed by quantitative determination of metalls. The results of chemical analysis are prezented in Table 4 and 5 and Figure 1.

Analyzing dates presented in table 4 and fig.1, we observed that steel slag resulted in steel obtaining process, does not content Na and K.

Calcium content has relatively near close values (34.3% for furnace slag and 26.5% for steel slag).

Magnesium content varies, being three times lower in furnace slag case.

The same low content we observed in iron and manganese content which in steel slag has 15 time higher values, than furnace slag.

In conclusion, furnace slag can represent a potential raw material for calcium and magnesium recovery, and steel slag, a potential raw material for calcium, magnesium, iron and manganese recovery.

TABLE 4. Average chemical composition of furnace slag and steel slag

Metals content (%)	Furnace slag	Steel slag
Na	0.24	-
K	0.33	-
Ca	34.3	26.5
Mg	2.7	8.7
Fe	1.96	21.0
Mn	1.37	11.7

TABLE 5. Metals content of F_5 and F_6 fractions, from steel slag

Metals	fraction	
	F_5 (90-250 µm)	F_6 (< 90 µm)
Ca	26.51	21.54
Mg	8.0	8.70
Fe	18.75	21.03
Mn	21.03	11.76

4. Conclusions

Experimental research showed the following:

- steel slag with a high content of iron and manganese could represent an important source for these trace elements;
- steel slag acid dezagregation could be used for trace elements (iron and manganese) extraction, for processing them into products with different using, respectively in trace elements fertilizer industry.

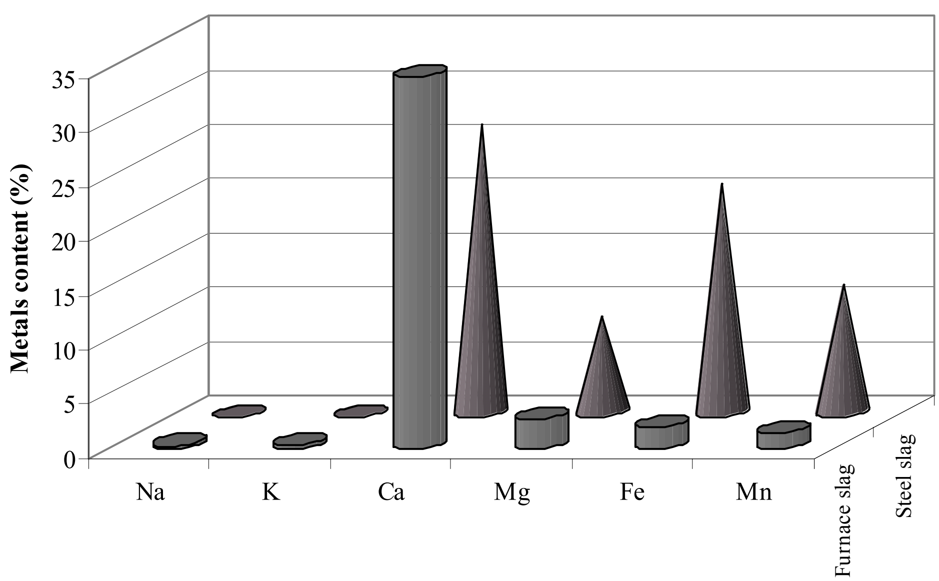

Figure 1. Metals percentage content of furnace slag and steel slag

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