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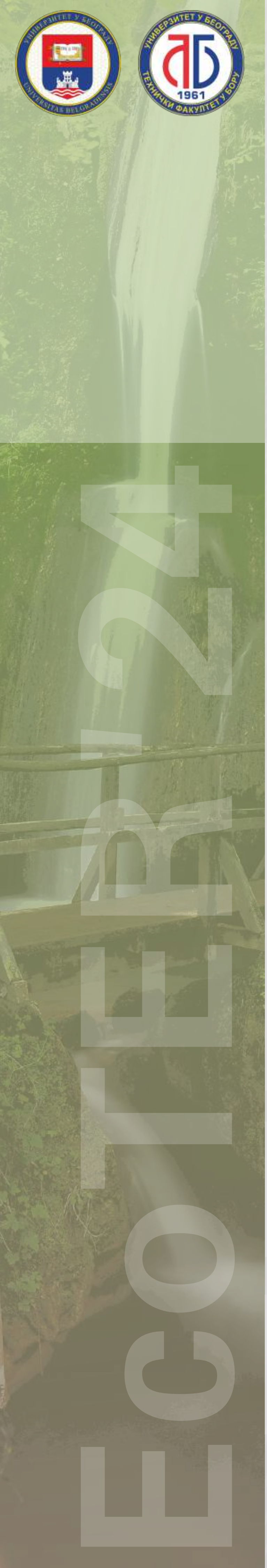

31st International conference

Ecological Truth & Environmental Research

Editor
Prof. Dr Snežana Šerbula

PROCEEDINGS

Hotel Sunce, Sokobanja, Serbia
18–21 June 2024

PROCEEDINGS

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PREFACE

The 31st international conference Ecological Truth & Environmental Research – EcoTER'24 focuses on showing the latest research findings and innovations in the field of ecology, environmental protection and sustainable development. The conference will be held in Sokobanja (Serbia) in hotel Sunce in the period of 18–21 June 2024.

The aim of the conference is to connect the experts in various fields in order to transform attitudes and behaviors in everyday practices, as well as in the industry and economy sector which is essential for achieving the desired changes that our society must undergo.

The 31st international conference Ecological Truth & Environmental Research – EcoTER'24 is organized by the University of Belgrade, Technical Faculty in Bor, and co-organized by the University of Banja Luka, Faculty of Technology; the University of Montenegro, Faculty of Metallurgy and Technology – Podgorica; the University of Zagreb, Faculty of Metallurgy – Sisak; the University of Pristina, Faculty of Technical Sciences – Kosovska Mitrovica and the Society of Young Researchers – Bor.

These Proceedings encompass 119 papers from the authors coming from the universities, research institutes and industries in 15 countries: Brazil, Norway, USA, Spain, Austria, Libya, Italy, Israel, Slovenia, Croatia, Romania, Bulgaria, Montenegro, Bosnia and Herzegovina, North Macedonia, and Serbia. It is a great honor and pleasure to cordially wish a warm welcome to all the participants of the conference.

As a part of this year's conference, the 6th Student Section – EcoTERS'24 will be held. We appreciate the contribution of the students and their mentors who have also participated in the conference and hope that students will continue to explore and to be curious, since education is a never-ending process, and knowledge is continuously growing.

The organization of the EcoTER'24 conference has been financially supported by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia.

The support of the Donors and their willingness and ability to cooperate has been of great importance for the success of the EcoTER'24 conference. The organizing committee would like to extend their appreciation and gratitude to the Platinum donors of the conference – Serbia ZiJin Copper doo Bor and HBIS SERBIA, to the Gold donor of the conference – Elixir Group, as well as to the Silver donor of the conference – Serbian Chamber of Engineers.

We would like to express our sincere appreciation to all the authors who have contributed to the Proceedings. We would also like to express our gratitude to the members of the scientific, organizing and honorary committees, reviewers, speakers, chairpersons and all the conference participants for their support of the EcoTER'24. Sincere thanks go to all the people who have contributed to the successful organization of the EcoTER'24.

Prof. Snežana Šerbula,

President of the scientific and organizing committee

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Student Section – EcoTERS'24

POSSIBILITY OF ZINC AND CADMIUM RECOVERY FROM HAZARDOUS INDUSTRIAL WASTE – EAF DUST

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Abstract

Electric arc furnace dust (EAF dust) is a hazardous solid industrial waste that needs to be disposed of in an adequate manner primarily for environmental protection. However, due to the high content of zinc and other useful components found in it, EAF dust can also be considered as a secondary raw material for their recovery. In this paper, experimental investigations of the application of hydrometallurgical treatment of the EAF dust to zinc and cadmium recovery were carried out. The treatment was carried out in two phases: 1st phase - pretreatment, 2nd phase - leaching with sulfuric acid. The leaching rate of monitored elements in the second stage of treatment was examined depending on the concentration of H_2SO_4 and the duration of the process. The highest Zn leaching rate of 65% and Cd of 80% were achieved at a concentration of H_2SO_4 of 1.50 M in a time of 20 min, at ambient temperature, and a S:L ratio=1:4.

Keywords: EAF dust, hydrometallurgy, treatment.

INTRODUCTION

As a result of the melting of waste iron at high temperatures in an electric arc furnace, in the steel production process, an intermediate product of the process occurs, *i.e.* electric arc furnace dust (EAF dust) [1–4]. This intermediate product is considered a hazardous solid industrial waste in many countries of the world since it contains heavy metals. The potential pollution of this type of waste consists in the possibility of self-leaching of the elements found in its composition, the most represented of which are: Zn, Fe, and Pb, while in smaller quantities can be found Cu, Ni, Cd, Pb, Mn, Ca, F, K, Cl and others [1,5–11]. If this type of waste is inadequately disposed of, surface and underground water pollution, or environmental pollution with heavy metals, may occur due to atmospheric influences. Considering that it is hazardous waste, it is necessary to carry out its treatment in an adequate way for environmental protection. EAF dust has a high zinc content in its composition (in the form of zincite - ZnO and zinc-ferrite - $ZnFe_2O_4$), and as such it can be seen as a source of secondary raw material for obtaining zinc, but also other useful components, such as cadmium for example. By applying adequate treatment, a double effect can be achieved - both environmental protection and profit-making [1,8,12,13]. Treatment of the EAF dust can be achieved using hydrometallurgical, pyrometallurgical, and combined processes. The problem in choosing an effective treatment procedure is that the chemical and mineralogical composition of each EAF dust from steel production is individual. For this reason, it is necessary to define optimal treatment conditions for each generated dust individually [1,2,5–7,13–15].

In this work, the characterization of a representative sample of the EAF dust was performed, and the possibility of zinc and cadmium recovery from the EAF dust was investigated using a hydrometallurgical procedure that includes two technological phases: pretreatment and acid leaching. The pretreatment of the initial sample of the EAF dust is carried out to selectively remove water-soluble components and involves a simple and inexpensive process of water leaching. The next phase involves acid leaching of the solid residue formed after pretreatment to zinc and cadmium recovery. The influence of the concentration of sulfuric acid and the duration of the leaching process on the zinc and cadmium leaching rate in the acid leaching process was investigated.

MATERIALS AND METHODS

Characterization of the initial EAF dust sample

The initial sample of the EAF dust was homogenized, and then the representative sample shown in Figure 1 was separated for chemical characterization using the quartering method.

Figure 1 *A representative sample of the EAF dust*

The chemical composition of a representative sample of the EAF dust is presented in Table 1.

Table 1 *Chemical composition of the initial EAF dust sample*

Element	Content, %	Element	Content, %
Zn	36.40	Cd	0.05
Fe	21.58	Ca	3.02
Na	1.18	Mg	0.76
Cl	2.90	K	0.99
Pb	1.86	Na	1.18
Si	1.69	Mn	2.12
Cu	0.19	Mg	0.76
Al	0.70	F	0.05

The greater number of elements present in the EAF dust occurs in the form of oxides, which is confirmed by the XRF analysis of the investigated EAF dust sample presented in Table 2. In the case of zinc, this element is present as zinc oxide (ZnO, zincite) with a share of about 50%, and as zinc-ferrite ($ZnFe_2O_4$, franklinite).

Table 2 *XRF analysis of the initial EAF dust sample*

Oxides	Content, %	Oxides	Content, %
ZnO	47.92	K_2O	1.409
Fe_2O_3	30.897	CaO	3.94
MgO	0.9288	TiO_2	0.155
Al_2O_3	0.6860	Cr_2O_3	0.519
SiO_2	3.619	Mn	3.334
P_2O_5	0.259	Cu	0.331
Cl	3.582	PbO	2.319

Experimental part

The hydrometallurgical treatment of the EAF dust applied in this paper, with the aim of zinc and cadmium recovery, was carried out in two phases: applying pretreatment, and then leaching with sulfuric acid.

Pretreatment

As the first technological phase of the hydrometallurgical treatment of the EAF dust, a simple and inexpensive leaching process of an initial representative sample of the EAF dust with distilled water was applied. The pretreatment was carried out to selectively remove water-soluble components from the initial sample of the EAF dust, with the following process parameters: water as a leaching reagent, temperature - ambient, ratio S:L=1:10, stirring speed - 500 rpm, time - 30 min.

Acid leaching

In the second technological phase of the EAF dust treatment, the effects of different concentrations of sulfuric acid and time on the zinc and cadmium leaching rate from the solid residue formed after the applied pretreatment were investigated. The following concentrations of sulfuric acid were investigated: 0.10 M, 0.25 M, 0.50 M, 0.75 M, 1.00 M, and 1.50 M. The time of the leaching process was investigated in the range of 5 to 60 min, while the temperature of 25ºC, the ratio S:L=1:4, and the stirring speed of 500 rpm were constant in all experiments.

RESULTS AND DISCUSSION

By applying pretreatment, selective removal of water-soluble components (Cl, K, Na, and Ca compounds) was achieved, which is convenient for the acid leaching process that follows, because in this way the consumption of leaching reagent (H_2SO_4) in the next phase, the acid leaching phase, is reduced. Also, the application of pretreatment avoids contamination of the resulting pregnant leaching solution with chlorides and other water-soluble components. Palimąka *et al*. [12], and Ruiz *et al*. [6] came to the same conclusion in their research.

Zinc and cadmium leaching rates depending on the concentration of sulfuric acid and the time of the acid leaching process are presented in Figure 2 (2a and 2b).

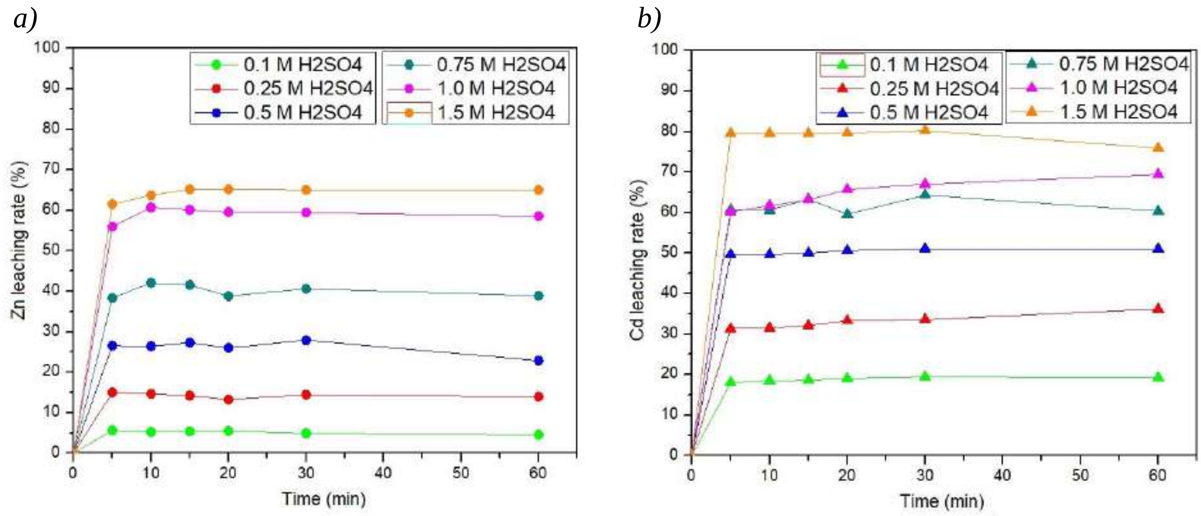

Figure 2 *Zinc and cadmium leaching rates depending on H_2SO_4 concentration and time: a) Zn; b) Cd*

Based on the obtained results, it can be concluded that the highest zinc leaching rates are achieved after 15–20 minutes, at all investigated concentrations of H_2SO_4, and then remain almost unchanged. During 20 min, the zinc leaching rate increases from 5.50% at an acid concentration of 0.10 M to 65.21% at a concentration of 1.50 M H_2SO_4. The highest cadmium leaching rates were reached in 20 min, after which the time parameter had no significant effect on the Cd leaching rate. Increasing the concentration of H_2SO_4, as well as the zinc leaching rate, has a favorable effect on the cadmium leaching rate so that the cadmium leaching rate ranges from 19% to 80% in a time of 20 min. The obtained results are in agreement with the research of Montenegro *et al*. [16], who also at ambient temperature, with a ratio S:L=1:5, in 20 min, with 1.00 M H_2SO_4, achieved a zinc leaching rate of 74% and cadmium of 87%. Hazaveh *et al*. [10] investigated the effect of H_2SO_4 concentration from 1.00 M to 3.00 M and concluded that the zinc leaching rate from the EAF dust sample increases with increasing H_2SO_4 concentration.

Further investigations will be carried out with the aim of zinc and cadmium recovery from the obtained pregnant leaching solution and obtaining commercial quality products.

CONCLUSION

Based on the investigation results obtained in this paper, it can be concluded that the EAF dust can be used as a secondary raw material for zinc and cadmium recovery. Hydrometallurgical treatment aimed at recovering these metals from the investigated EAF dust sample is applicable and achieved a relatively high leaching rate of both monitored elements. After the applied pretreatment aimed at the selective removal of water-soluble components from the initial sample of the EAF dust, in the acid leaching phase, at ambient temperature, at a concentration of H_2SO_4 of 1.50 M, the ratio S:L=1:4, in a time of 20 min, it was achieved zinc leaching rate of 65%. With the same parameters of the leaching process, a cadmium leaching rate of 80% was achieved. Our future investigations will be directed towards the zinc and cadmium recovery from the obtained pregnant leaching solution.

ACKNOWLEDGEMENT

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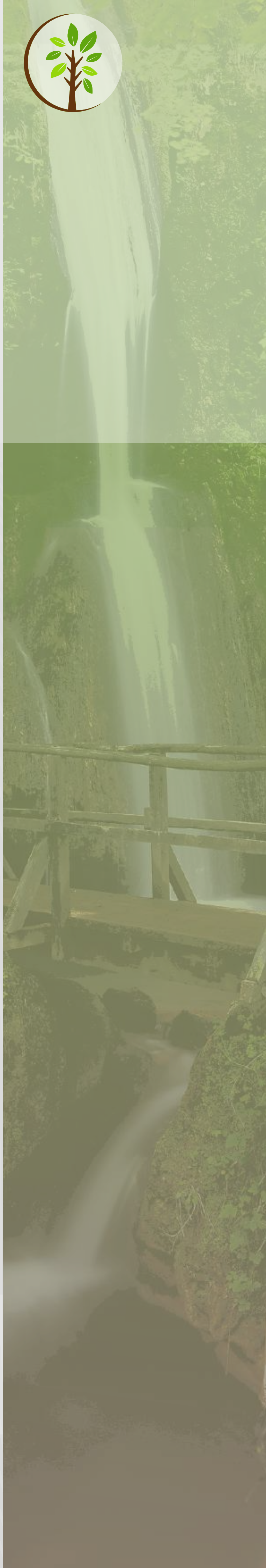

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