

POSSIBILITY OF WASTE SLAG TREATMENT FROM FACTORY FOR CUTTING TOOL

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ABSTRACT

This work gives a possibility for waste slag treatment from thermal treatment of cutting tool. The aim of this investigation is transformation of slag components (Ba, Ca, Mg, Na and K) into undissolved forms what will make such treated slag as harmless for the environment. Experimentally the following was established:

- Slag dissolubility in distilled water
- Possibility of Ba^{2+} deposition in a form of undissolved $BaSO_4$
- Possibility of SO_4^{2-} surplus deposition in a form of undissolved $CaSO_4$ and Mg^{2+} in a form of undissolved $Mg(OH)_2$
- Possibility of transformation the strong dissoluble Na^+ and K^+ into undissolved Na_2SiF_6 and K_2SiF_6 silicofluorides.

Keywords: slag, thermal treatment, dissolvability, deposition

1. INTRODUCTION

The rapid depletion of high grade ores and increasing demand for base materials has prompted intensive investigation and developments into materials recovery from industrial wastes. Industrial wastes are usually hauled to dump sites. However, if these wastes become solubilized due to the acid conditions occurring in the dumps, they may contaminate underground water supplies. Disposal of industrial wastes in the land is environmentally unsafe, and the practice needs to be stopped [1, 2].

In the factory for cutting tool, the tools are heat-treated in the cast of different salt mixtures. After definite period, said salt mixtures for thermal treatment are replaced and deposited as waste slag. Because, the slag is highly soluble in water, its disposal is restricted by environmental regulations and consequently, it has to be chemically treated and transformed into undissolved harmless form adequate for disposal.

From the factory were obtained three different samples of waste slag:

1. Composition of all waste slag recently used for the cutting tool hardening,
2. Black slag obtained in the cutting tool annealing process on 490°C,
3. Slag from a factory dump.

Total amount of the slag samples was crushed and subsequently grinded to - 700µm granulation.

2. EXPERIMENTAL PART

The first stage of experimental testing was to evaluate dissolubility of slag samples in distilled water. After dissolution and filtration, percentage of leaching was calculated based on the residue weight. The obtained solutions were chemically analyzed in order to determine the content of Ba, K, Na, Ca and Mg. Based on the determined concentration of metals present in the solutions, quantities of chemicals needed for the metal deposition, in the form of insoluble salts, has been calculated.

Deposition of Ba²⁺ in the form of insoluble barium sulfate was carried out according to the following reaction:

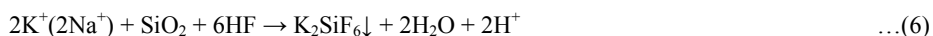


In this way, barium is completely removed from the solution, this has been proven by chemical analysis. At the same time, RD analysis confirmed that the obtained precipitation was barium sulfate. The filtrate marked with Fra-1a, after separation of barium sulfate precipitate, is very acidic (pH = 1), to neutralize this solution, 10% lime milk was used. During neutralization, excess sulfate ions from sulfuric acid were converted into insoluble calcium sulfate, while the soluble form of magnesium was transformed into insoluble magnesium hydroxide, according to the reactions [2]:



Precipitated calcium sulfate and magnesium hydroxide were separated and subjected to the XRD analysis, a part of the filtrate was chemically analyzed. Chemical composition of the filtrate, marked with Fra-1b, is shown in Table 2. This filtrate was further treated in order to remove sodium and potassium.

Taking into account the high solubility of sodium and potassium salts, it was concluded that the only possible way for their removal is precipitation with silico hydrofluoric acid and silicon dioxide in the form of insoluble silicofluoride, as follows [3]:



XRD analysis of the obtained residue confirmed assumption of its chemical composition as the mixture of sodium and potassium silicofluorides. The filtrate, marked with Fra-1c, after the separation of said residue, was chemically analyzed in order to determine its chemical composition and the possibility of discharge such solution into the watercourse.

3. RESULTS AND DISCUSSION

Table 1. shows the results of leaching 100 g of each slag sample in 2 dm³ of distilled water. Dissolution was carried out at elevated temperature, 50±5 °C, during six hours.

Table 1. The results of leaching slag samples

Exp. No	SLAG TYPE	LEACHING (%)
1.	Waste slag used for tool hardening	79.2
2.	Black slag from tool annealing process on 490°C	85.8
3.	Slag from a factory dump	72.7

After dissolving the samples of the slag in distilled water and separation of the residue, was carried out chemical analysis of filtrates marked as Fra-1, Fra-2 and Fr-3. The results of this analysis are shown in Table 2.

Table 3. represents the results of further chemical treatment of the filtrate Fra-1, formed by dissolving waste slag used for tool hardening. The filtrate obtained after precipitation and separation of barium sulfate is labeled Fra -1a, upon deposition of calcium sulfate and magnesium hydroxide resulted in the filtrate Fra -1b. From this filtrate, after sedimentation of the potassium silico fluoride and sodium silico fluoride, filtrate Fra - 1c was obtained.

Table 2. Metal content in the filtrates

Chemical element	Fra – 1 (g/dm ³)	Fra – 2 (g/dm ³)	Fra – 3 (g/dm ³)	Analytical methods*
Ba	14.45	10.45	22.20	VT
Ca	0.72	3.61	0.07	AAS
Mg	0.00024	0.0003	0.00096	AAS
Na	2.22	2.39	0.61	AAS
K	1.73	0.074	0.38	AAS

*VT - Volumetric titration, AAS - Atomic absorption spectrophotometry

Table3. Metal content in the filtrates after deposition of: BaSO₄ (Fra-1a), CaSO₄ and Mg(OH)₂ (Fra-1b), K₂SiF₆ and Na₂SiF₆ (Fra-1c)

Chemical element	Fra – 1a (g/dm ³)	Fra – 1b (g/dm ³)	Fra – 1c (g/dm ³)	Analytical methods*
Ba	<0.001	<0.001	<0.001	G/ICPAES
Ca	0.66	0.31	0.00071	AAS
Mg	0.00022	0.00012	0.001	AAS
Na	2.51	1.32	0.047	AAS
K	1.63	0.75	0.025	AAS

*G/ICPAES – Gravimetry / Inductively coupled plasma atomic emission spectrometer

4. CONCLUSION

Based on the experimental testing of the possibility of chemical treatment of waste slag from the cutting tool factory with the aim of removing the present elements soluble in water (Ba, Ca, Mg, Na, K), can be concluded:

1. Leaching of slags with distilled water at 50 °C was achieved about 80% leaching
2. By chemical treating of the obtained solutions from dissolving slag, it is possible to remove the present metals, and without fear of contamination, after treatment, discharge into the watercourse.
3. The results of this research indicate that it is possible to produce barium sulfate from waste slag as raw materials for other chemical processes.

The ability to produce chemicals from waste slag offers the possibility of savings in raw materials and energy costs. On the other hand, pollution potential of metal finishing industry would be minimized by establishing this kind of ultimate disposal program.

5. ACKNOWLEDGMENT

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