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Elimination of chloride and fluoride from raw zinc oxides derived from steel dusts processing

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Abstract

On the account of diminished recourses of zinc ores and large requirement on metallic zinc as well as its compounds the recyclable materials are used in larger extent. For example the steel dust serves for obtaining raw dust of zinc oxide as a by-product. This dust contains undesirable components such as chlorine and fluorine. Presented work aims to eliminate these components from the raw zinc oxide obtained from the steel dust because in the case of its hydrometallurgical processing these impurities are liable for the corrosion of zinc and decreasing of technical and economical indexes. Removal of the chloride and fluoride ions was conducted in two stages: first – previous removal on the way of the water leaching, and the second – connected with the removal of above impurities by the soda solutions. Effect of the temperature on the degree of these impurities removal was determined. It was found that the degree of removal of chloride did not depend on the temperature of the process as well as on the amount of used soda on the contrary in the case of fluoride removal.

Key words: waste, receiving zinc, elimination

Introduction

The interest on the secondary sources of zinc is dictated by the large demand on zinc, resulting from the increase of the requirement on the protection by the zinc coating common use in the building engineering and car industry.

At beginning of this century in our country the consumption of zinc recyclable materials amounted to 3 % whereas in the highly industrialized countries as Germany or Great Britain it was totalled on level of 30 per cent. The zinc compounds such as sulphates, phosphates and other are produced practically from the secondary materials at present. The costs of these salts producing from the above materials are lower than the costs of salts obtaining from the natural raw materials. Further the technologies of their salts obtaining from the secondary materials are friendly for environment (Jarosiński, 2007; Jha et al., 2001).

The industrial experience indicates more and more application of the recyclable materials in technological processes. Such trends favour development of recycling technologies.

More than the mined ore and processed metallic zinc and its compounds, there is used the zinc waste deriving from steel industry, for example the dust from the electric arc furnaces, dust of blast-furnaces or rolling scales (Havlik et al., 2006; Zięba et al., 2007). The obtained zinc oxide from such materials contains halides. For example the presence of the chloride anions in electrolyte for obtaining of cathode zinc contributes to zinc corrosion as well as to decreasing of the current efficiency or of zinc quality. The presence of these impurities in the zinc compounds is also undesirable especially in products used as microelements in admixtures of feeds.

For the removal halides from the zinc oxides two ways are used. The first way is connected with the chlorides removal by washing. The second solution relies on the thermal treatment. In practice the first solution is preferred.

In this work the investigation on removal of some impurities contained in zinc oxide derived from the processing of the steel dust.

Experiments

In the laboratory experiments the zinc oxides derived from one of domestic plants were used. The process of the chloride and fluorides obtaining from the raw zinc oxide is operates in two stages. In the first stage of the preliminary removal of chlorides the washing of the soluble salts is done by the water as a washing agent. The mass ratio of the liquid to solid phases has amounted to 9 : 1. The reaction was performed in thermostatic flask at the temperature 60 ± 0.1 °C.

The purpose of the second stage was the removal of fluorides as well as the traces of chlorides remaining after first the step. The elimination of fluorides as well as chlorides succeeds by the washing of soluble salts. The agent was the water solution of the sodium carbonate. Quantity of the soda in relation to used samples derived after the first stage amounted to 5, 10 and 15 %. The mass ratio of liquid to solid phase amounted to 9 : 1, too. The washing was carried out at temperatures ranges 60 – 90 °C. Time of treatments was up to 2 hours.

Results and discussion

The chemical composition of tested zinc oxide is presented in Tab. 1. Results of the fluorides and chlorides elimination after two stages of washing are recapitulated in Tabs. 2 and 3.

On the basis of obtained results the degree of chlorides and fluorides elimination was calculated using following formula:

$$\alpha = \frac{x_i - \frac{x_{Znp} \cdot m_p}{x_{Znk}} \cdot c_i}{x_i} \cdot 100[\%]$$

where: x_i – content "i" component in initial samples [%], x_{Znp} – content of zinc in initial sample [%], x_{Znk} – content of zinc in sample after washing [%], c_i – concentration of "i" component after II stage of washing.

The dependence of the degree of chlorides elimination on the content of soda in washing agent and on temperature is shown in Tab. 4 together with the obtained results of the degree of fluoride elimination for various soda contents in the washing agent.

Tab. 1
The chemical composition of tested zinc oxide

Metal	Zn	Fe	Pb	Cl	F
Content [%]	59.5	3.15	6.42	5.9	0.12

Tab. 2
Test results after 2. stage of washing

Condition		Content of components in solution [%]		
Na_2CO_3 [g]	T [°C]	Zn	Cl	F
5	60	67.29	0.028	0.0745
	90	66.39	0.020	0.0510
10	60	66.52	0.023	0.0655
	90	66.25	0.012	0.0390
15	60	65.97	0.0195	0.0580
	90	65.88	0.0110	0.0360

Tab. 3
Chemical composition of 2. stage of washing

Condition		Content of component in solution [g/dm^3]		
Na_2CO_3 [g]	T [°C]	Zn	Cl	F
5	60	0.0090	0.74	0.045
	90	0.0027	0.96	0.068
10	60	0.0010	0.78	0.056
	90	0.0011	1.02	0.081
15	60	0.0022	0.92	0.068
	90	0.0037	1.06	0.088

Tab. 4
Dependence of the degree of chloride elimination on soda amount in the solution

Condition		Degree of elimination [%]	
Na_2CO_3 [g]	T [°C]	Cl	F
5	60	99.58	45.11
	90	99.70	61.91
10	60	99.65	51.17
	90	99.82	70.81
15	60	99.70	56.41
	90	99.83	72.91

The presented data indicate that degree of elimination of chlorides was high and practically reached 100 %. It was found that degree of chlorides elimination does not depend in essential way on the temperature of the process. Degrees of fluorides elimination from tested material were lower than the degrees of chlorides and fitted into the range 45 – 73 %. Efficiency of fluorides elimination in two stage process of washing depends on the temperature as well as the amount of the soda addition. Increase of the temperature process was beneficial on the degree of fluoride elimination.

Conclusions

The test results allowed to state that two stage process of washing of the zinc oxide in the purpose of halides elimination is effective. Degree of the chlorides elimination was very high reaching almost the value of 100 %. This degree does not depend on the temperature treatment.

Degree of fluoride elimination at the temperature 90 °C is high and amounts to 73 %. Efficiency of discussed treatment depends on temperature as well as soda content in the washing agent.

References

HAVLIK, T., SOUZA, B. V., BERNARDES, A. M., SCHMEIDER, I. A. & MISKUFOVA, A., 2006: Hydrometallurgical processing of carbon steel EAF dust. *J. Hazardous Materials (B 135), 313 – 318.*

JAROSIŃSKI, A., 2007: Exemplary solutions of zinc raw materials processing. *Recyklace odpadu IX, Košice, 177 – 183.*

JHA, M. K., KUMAR, V. & SINGH, R. J., 2001: Review of hydrometallurgical recovery of zinc from industrial wastes. *Resources, Conservation and Recycling, 33, 1 – 22.*

ZIĘBA, T., ŻELAZNY, S. & JAROSIŃSKI, A., 2007: Analiza możliwości odzysku cynku z pyłów z pieca łukowego metodą hydrometalurgiczną. Międzynarodowa Konferencja Naukowa, Teoretyczne i praktyczne zagospodarowanie odpadów hutniczych i przemysłowych, Zakopane, 34 – 39.

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