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Pb(II) leaching from waste CRT funnel glass in nitric acid solutions

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ABSTRACT

Purpose: The paper presents experimental results of Pb (II) leaching from waste CRT funnel glass using solution of nitric acid (V) . This work focused on examining the impact of concentration and particle size on the leaching percentage of Pb (II) from funnel glass.
Design/methodology/approach: Material for the investigation was crushed and sieved. Leaching was carried out using working solutions pfrom co repared ncentrated HNO_3 and mechanical stirrer.
Findings: The received results show the possibility of find the parameters of leaching that could remove the whole Pb(II) from funnel glass.
Practical implications: Results after additional research can be applicate by glass industry.
Originality/value: Worked out technologies can be used in glass recycling and production.
Keywords: Leaching; CRT glass; Lead; Experimental laboratory research; CRT funnel

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1. Introduction

CRT (Cathode Ray Tube) technology is used in most of the old television sets and computer monitors. There are two types of CRTs: color and black-white. CRT provides up to 65% weight of a computer or TV, and 85% is made of glass containing significant amounts of lead as PbO. CRT lamp contains four different CRT glass elements, which are shown schematically in Fig. 1.

Cathode Ray Tubes waste glass (CRTs depleted glass) are polymetallic carriers of many heavy metals such as Pb (Fig. 2), Ba or Sr . It should be emphasized that the chemical composition of individual parts of the glass material is varied depending on the manufacturer, date of manufacture, but also on the tasks that have to be fulfilled [1-2]. Lead glass from CRT depleted storage requires a specially adapted area, which represents a substantial financial outlay.

Funding for this waste causes the resulting lead and other hazardous compounds can be washed into the soil, where they can get into surface water and ground water which has a negative impact on both flora and fauna of the environment. Up to 13% of Pb contained in the glass of CRT can penetrate the soil and water. Its dictated the need to develop appropriate methods of solving the problem of constantly increasing the amount of waste CRT. Waste of this type may be subject to recovery, not only for economic benefits, but also to meet the ecological requirements. Development of this type of waste is not an easy task given the limitations of its arrangement in a closed loop of recycling. Currently, glass is trying to use in road construction and metallurgy. Glass from exploited CRTs can be recycled after removal of the lead and after minimize the content of strontium and barium [3-4]. Therefore, it is important to search for methods that allow the use of waste as secondary raw material in various branches of the economy. An alternative solution to the problem of waste CRT glass can be applied hydrometallurgical methods that can allow remove lead from the glass, reducing its amount or any conduct it into the metallic state.

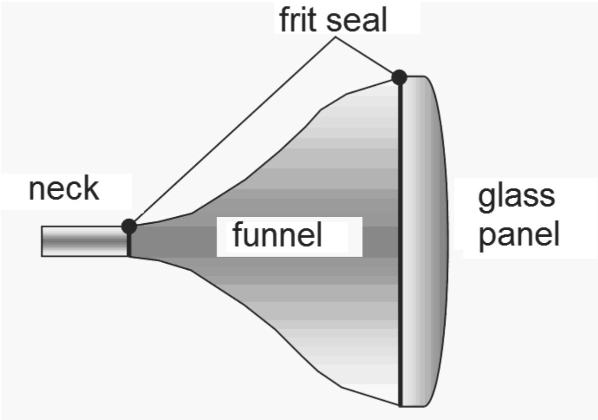

Fig. 1. Schematic of CRT

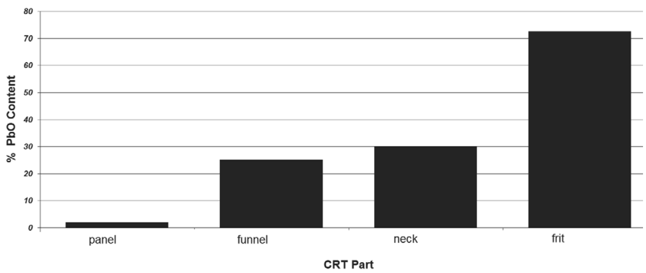

Fig. 2. PbO contain in CRTs

2. Experimental procedure

For studies on leaching of Pb (II) a glass tube from waste Cathode Ray Tubes monitors from different manufacturers was used. CRT glass prior to testing has been cleaned from the remains of other parts than the glass and subjected to a crushing with a laboratory crusher jaw type BB1 with a width of 3 cm. Subsequently, the glass was crushed and dry sieved through vibrating screen type 3D Digital for fractions of the three grain sizes: 0.5 mm, 0.5-2 mm and 2-4 mm. Fig. 3 shows photographs of the glass fraction tested.

The process of leaching of the sample was subjected successively, whose weight was 1 g, using 10 cm^3 of leaching solution. Leaching was carried out at room temperature (20 ± 2°C) for 180 minutes. Samples were mixed by mechanical stirrer (Fig. 4) which speed was 200 revolutions per minute. Leaching was carried out using working solutions prepared from concentrated HNO_3 with analytical purity and 4 grade of concentrations:

- mol/dm^3,
- 0.25 mol/dm^3,
- 0.5 mol/dm^3,
- 1 mol/dm^3.

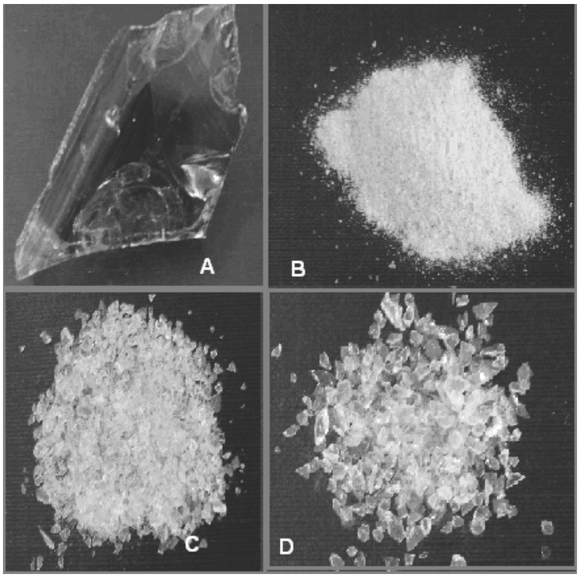

Fig. 3. CRT waste glass tested fractions: A- piece of funnel glass, B- less than 0.5 mm, C- 0.5-2 mm, D- 2-4 mm

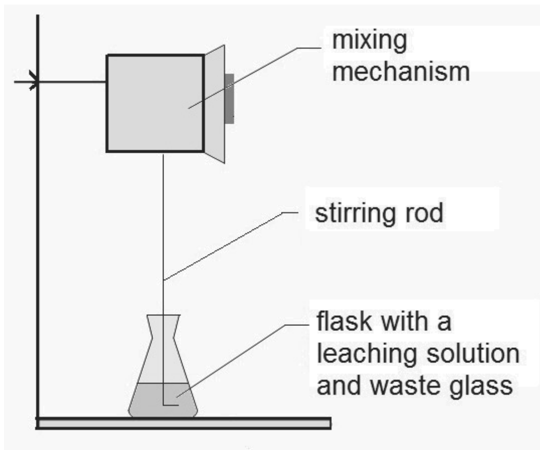

Fig. 4. Research station

Samples for analysis were taken during the process after 60, 120 and 180 minutes. The samples after appropriate dilution were analyzed for concentrations of Pb (II) ions by atomic absorption spectroscopy ASA. For the calculations the average values were taken. It was assumed that the tested CRT glass tube contains 20.5% Pb.

3. Results and discussion

Fig. 5 shows Influence of solution concentration on Pb (II) leaching efficiency (R%) at the time for the fraction with a grain size below 0.5 mm. It may be noted that during the process are reached very low levels of leaching efficiency, it do not reach even 1%, which is evidenced by the fact that for the study were used very low concentrations of acid. Best results were achieved for the highest acid concentration which was used for experiments.

Fig. 6 shows the effect of glass particle size on leaching efficiency of Pb (II) at the time, the concentration of 1 mol / dm^3 . Also in this case high leaching efficiencies were not achieved, but among all the fractions studied, the best was the fraction with the largest particle size, in particular 0.5-2 mm fraction.

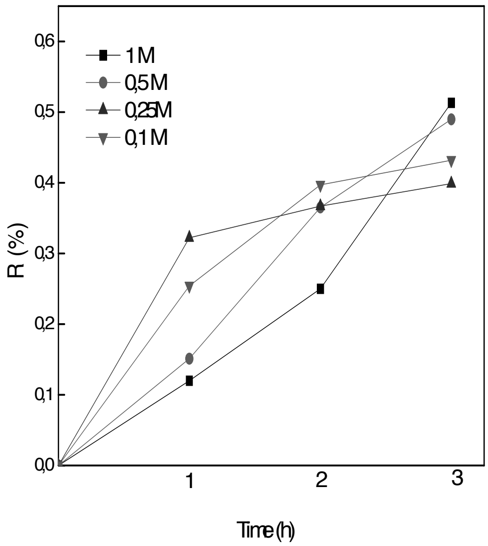

Fig. 5. Influence of solution concentration on Pb (II) leaching efficiency at the time for the fraction with a grain size below 0.5 mm

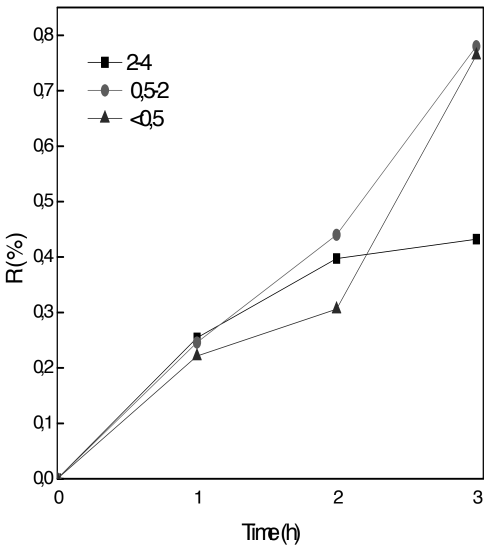

Fig. 6. Effect of glass particle size on leaching efficiency of Pb (II) at the time, the concentration of 1 mol/dm^3

4. Conclusions

Today more and more attention should be devoted to the appropriate solution to the growing number of CRT glass in the waste stream and waste deposit which is still used by consumers. Used to study different fractions and acid concentrations has a significant impact on the leaching of Pb (II) from waste CRT glass. Choosing the appropriate conditions for leaching of lead from waste CRT glass (such as reagent concentration, process temperature, the effect of contact time with the regent, or grain size), may allow the leaching of the total amount of lead contained in waste glass of cathode ray tubes at low concentrations, and select the right methods of separation. In conclusion, further research hydrometallurgical processing of waste CRT glass may allow the development of recycled lead in non-ferrous metal. Removal of Pb (II) of glass will allow the use of it in the glass industry.

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