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Inertisation and recovery of mining wastes by manufacturing glass

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Tailings from tin mining processes contain high concentrations in pollutant elements that produce environmental contamination. Vitrification offers an alternative for the stabilization of these hazardous wastes, since these elements are sequestered in a glassy matrix. In addition, this method of remediation constitutes an additional income to the mining activity.
The present work investigates the contamination of tailings from the tin mining activity of Llallagua (Bolivia) and its viability to be used to the elaboration of glass. Tailings from the processing of tin ore deposits are abundant in Bolivia. Mining activity of tin in Llallagua produced important amounts of wastes that contaminate waters and produce acid drainage. The analyses of these tailings reveal high contents in As (134 to 4600 ppm), Pb (107−950 ppm) and Zn (44^{-1}100 ppm). After mineral recovery the Sn content is still very high, in most cases, from 0,2 to 0.4 wt% SnO_2.
Three samples, two of them of sands and another of lime from the refinement tailing, were selected to prepare the glass. The chemical composition of the tailing raw material was determined by X-ray fluorescence. Tailings have 73−82 wt% SiO_2, 12^{-1}7 wt% Al2O_3, 2.4−4.1 wt% Fe2O_3, 0.7−3.2 wt% K2O, 0.5^{-1}.4 wt% MgO, 0.2−0.7 wt% TiO_2, 0.1− 0.5 wt% CaO, 0.2−0.3 wt% P2O5, and up to 0.4 wt% SO_3. The mineralogy of the tailing consists mainly of quartz, accompanied by minor amounts of phyllosilicates and tourmaline.
Based on this composition two different types of glass were formulated: a silica glass and borosilicate glass of Vycor-type.
In addition to the tailing raw materials, $CaCO_3$ and Na2CO_3 were added to make the silica glass, and $H3BO_3$ and Na2CO_3 for the borosilicate glass. This mixture was introduced in crucibles of alumina-mullite, and of platinum in the second case, and conducted to the eutectic temperature to melt the raw materials.

Differential thermal analysis (DTA) of the glass was used to plan the thermal cycle. Crystallisation temperature is about 950 ºC in the case of silica glass and slightly lower for the borosilicate glass. The melting temperature was 1150 ºC. The transition temperature (Tg) of each glass was determined by dilatometry. Tg values of silica glass are between 620 ºC and 700C °C, and of 499 ºC in the borosilicate glass. To make the viscosity-temperature curve the viscosity was determined using a heating microscope.
The obtained glasses have good resistance to chemical attack and can be used for industrial or building applications.
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