Use of glass waste for the encapsulation of metals and metalloids present in mining waste

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Introduction

Mining is one of the main causes of heavy metal pollution, mainly due to the handling of contamination of its waste (tailings). (Ramos et al., 2012). The recovery of tailings is contemplated in the United Nations Sustainable Development Goals (SDGs), mentioning that mining can contribute this type of waste to the construction of sustainable cities and communities (World Economic Forum, 2016).

One way to valorize the tailings is through the solidification-stabilization technique, in this technique cement Portland is used as a binder. The replacement of cement by borosilicate glass has a positive effect since it modifies the mechanical properties (Bagheri et al., 2017). The objective of this research was to evaluate the use of borosilicate glass as a partial substitute for Portland cement in the solidification-stabilization technique.

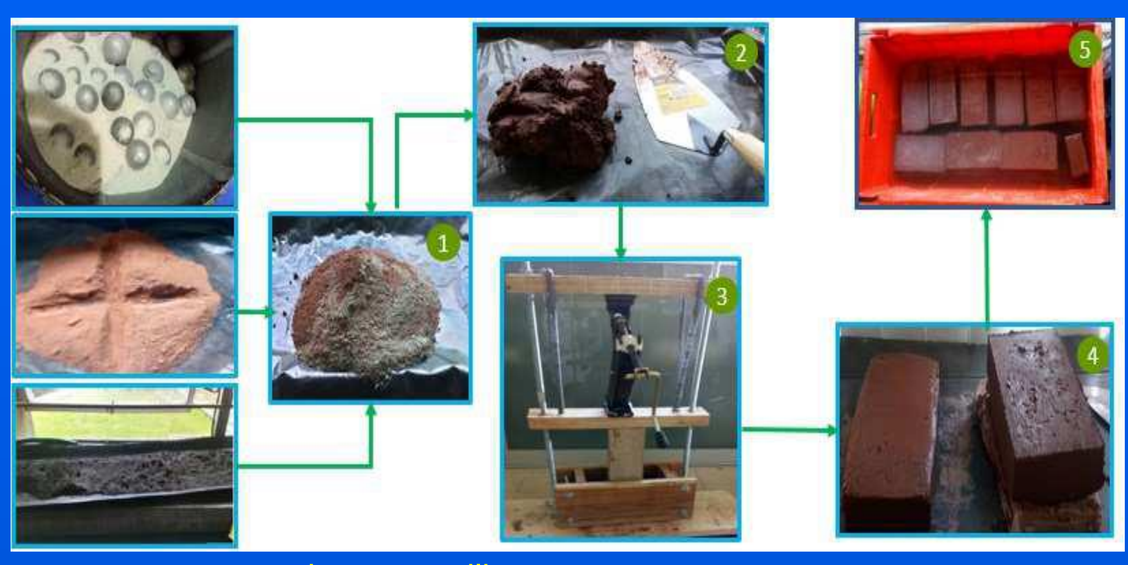

Figure 1: Tailings reuse process

Results & Discussion

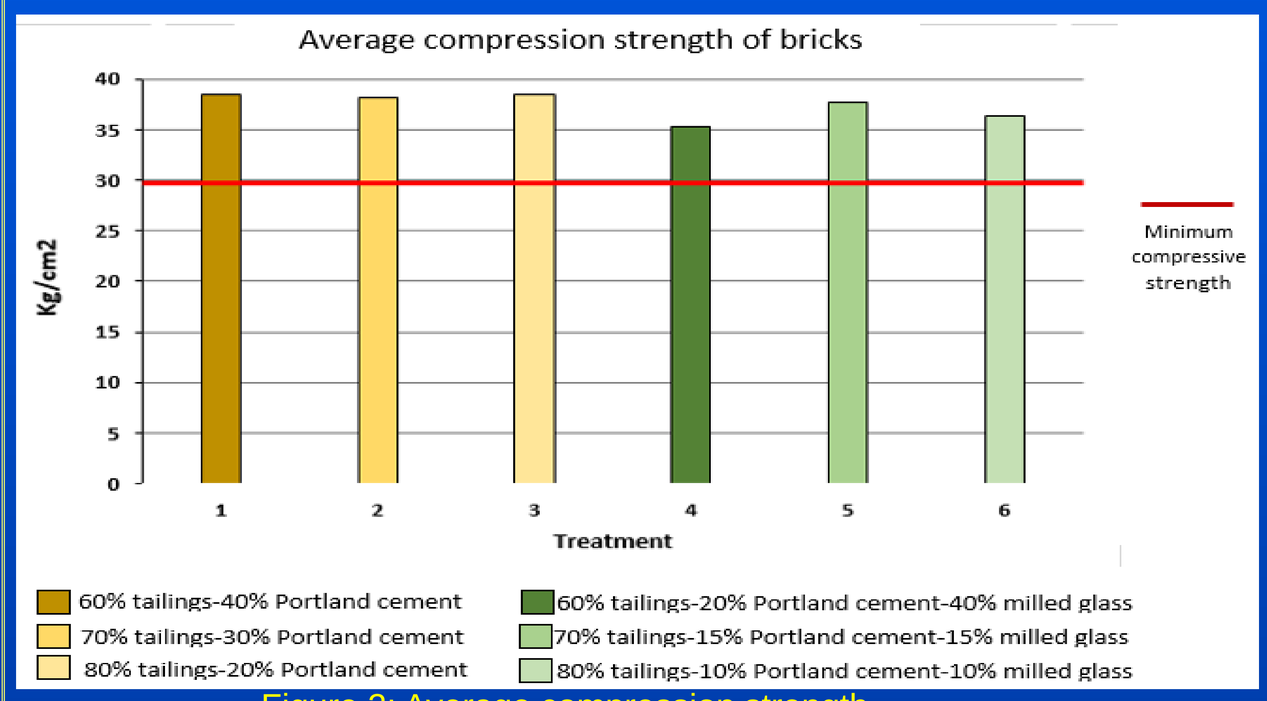

Figure 2: Average compression strength

- The determination of metals and metalloids showed the presence of 15 metals; Rb, Zn, Ni, Sr, Mn, Ti, Ba, Ca, Fe, Cu, Cr, V and 2 metalloids; As and Sb.
- The Sb exceeded the limit established in the Mexican standard NOM-157-SEMARNAT 2009, 10.6 mg / kg also exceeded the value allowed in the leachate 2.4 mg / mL
- (Figure 1) All treatments exceeded the minimum resistance to compression established in the Mexican standard NMX-C-441-ONNCE-2005. The above indicates that milled glass is a good replacement for Portland cement.

Response: resist	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	1	3.253	3.253	2.5315	0.1868
Residuals	4	5.140	1.285		

With α = 5%, the anova shows that there is no significant difference between treatments.

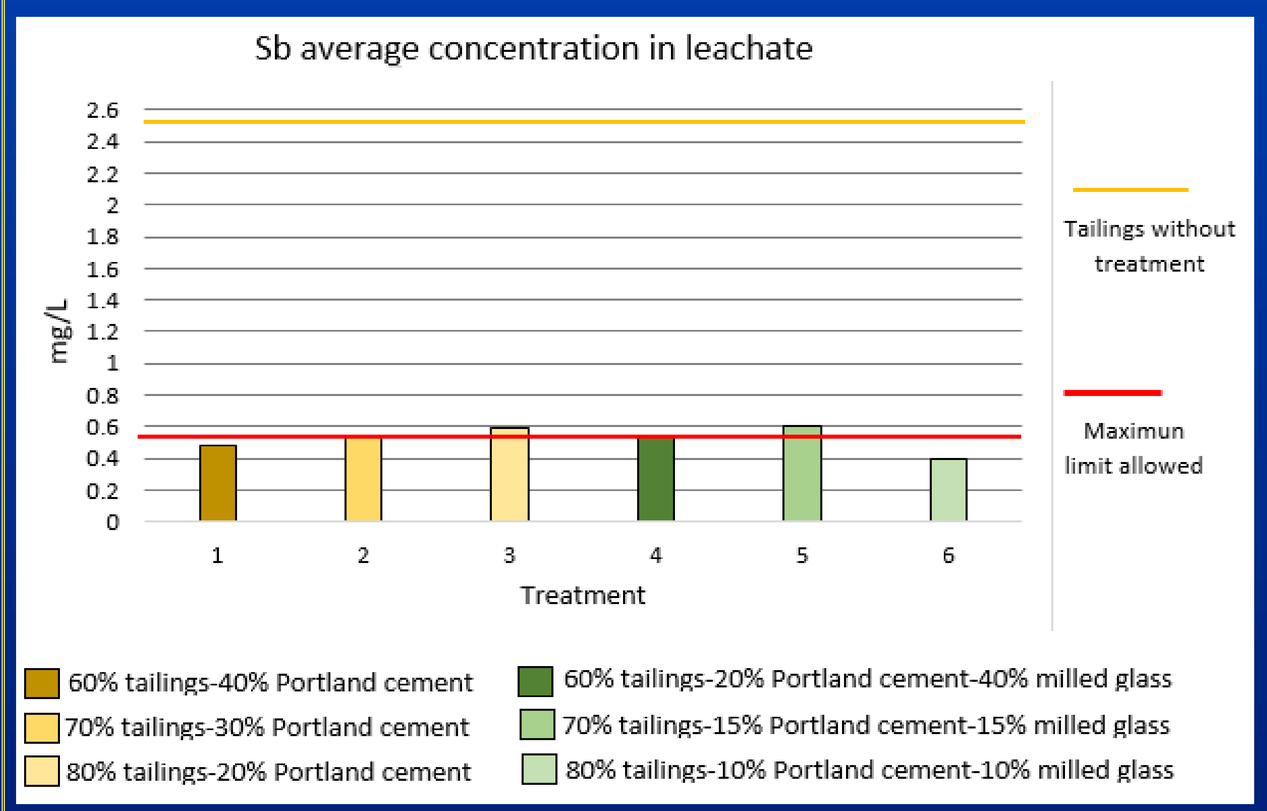

Figure 3: Antimony average concentration in leachate

- Using cement and milled glass reduces the concentration of Sb in the leachate from 2.4 mg / L to approximately 0.5 mg / L.
- The treatments 1, 2, 4 and 6 are below the maximum allowed limit, while treatments 3 and 5 exceed this value.

Response: concentration	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	1	0.0012943	0.0012943	0.1785	0.6944
Residuals	4	0.0290069	0.0072517		

With α = 5%, the anova shows that there is no significant difference between treatments.

- In the first three treatments, it is observed that the lower the amount of cement, the less encapsulation of Sb, the same trend is observed in treatments 4 and 5, however, treatment 6 shows a different value which can be attributed to a measurement error.

Conclusions

The solidification-stabilization technique is suitable for reuse and treatment of tailings, likewise, milled glass can replace a certain amount of cement without losing resistance to compression and encapsulation of Sb.