Geophysical Research Abstracts
Vol. 17, EGU2015-8632-2, 2015
EGU General Assembly 2015

P_2O_5-doping in waste glasses: evolution of viscosity and crystallization processes

Mariona Tarrago, Alex Espuñes, Maite Garcia-Valles, and Salvador Martinez
Dept. Cristal·lografia, Mineralogia i Dipòsits Minerals, Facultat de Geologia, Universitat de Barcelona, Spain (mtarrago@ub.edu)

Current concern for environmental preservation is the main motive for the study of new, more sustainable materials. Increasing amounts of sewage sludge are produced in wastewater treatment plants over the world every day. This fact represents a major problem for the municipalities and industries due to the volume of waste and also to the contaminant elements it may bear, which require expensive conditions for disposal in landfills. Vitrification is an established technique in the inertization of different types of toxic wastes (such as nuclear wastes and contaminated soils) that has been used successfully for sewage sludge.

Glasses of basaltic composition (43.48SiO_2-14.00Al_2O_3-12.86Fe_2O_3-10.00CaO-9.94MgO-3.27Na_2O-1.96K_2O-0.17MnO-0.55P_2O_5-2.48TiO_2) are used as a laboratory analogous of wastes such as sewage sludge and galvanic sludge to study the properties of the inertization matrix. This basaltic matrix is doped by adding 1%, 2%, 3%, 4% and 20% of P_5O_5 in order to cover the compositional range of phosphate in sewage sludge encountered in the literature. In this study, the focus has been placed in the effect of the concentration of phosphate (P_2O_5) in glass stability, thermal properties and evolution of viscosity with temperature. The dependence of viscosity on temperature and the thermal behaviour of these glasses are critical parameters in the design of their production process.

Regarding the compositional limits of the mixture, it has been observed that melt reactivity is much increased when P_2O_5 content is over 4%, hindering the glass conformation process. Moreover, stanfieldite (calcium and magnesium phosphate) crystallized during glass making when phosphate concentration approached 20%, hence establishing the upper limit for glass stability. Viscosity is also dramatically increased in this range, hence requiring production amends.

Differential thermal analysis has provided nucleation and crystallization temperatures of the glasses around 915ºC and 1050ºC respectively at phosphate contents up to 4%. Subsequent analysis by X-Ray Diffraction has proved that newly formed phases are iron oxides, Ca – Mg silicates and feldspars.

Glass transition temperature (Tg; approximately 635ºC) obtained by dilatometry remains almost constant until very high phosphate contents; even then, the increase is not large (650ºC at 20% P_2O_5).

Hot-Stage microscopy (HSM) has shown the evolution of viscosity with temperature through the analysis of the morphological evolution of cylindrical probes of glass according to German standard DIN 51730. The annealing range (viscosity between $10^{13.5}$ and 10^{12} is reached at temperatures between 600 and 700ºC. The temperatures of the lower limit of the working range (viscosity under 10^3 Pa·s) are between 1325 and 1375ºC; decreasing slightly with the addition of P_2O_5.