Paper Number: 2749

Preliminary Screening of Gold Mine Tailings in the Context of Acid Mine Drainage and Geopolymerization

Pieterse, L.[a], van der Merwe, E.M.[b] and Doucet F.J.[a]

[a] Council for Geoscience, Pretoria, South Africa.

[b] Department of Chemistry, University of Pretoria, South Africa

---

The Council for Geoscience (CGS) is currently investigating several options for the development of appropriate management measures to resolve issues associated with acid mine drainage (AMD). Each year, the mining industry generates a significant amount of mine tailings. Storage of these tailings occupies large areas of land and leads to high monetary, environmental and ecological costs. This project is based on the hypothesis that future AMD prevention could be prevented if gold mine tailings were used as starting aluminosilicate sources for the synthesis of geopolymeric materials and subsequent stabilization.

Geopolymers are mineral binders which can be used, for instance, in cement manufacturing. For instance, VicRoads, the state roads authority in Australia, has recognized geopolymer concretes as being equivalent to ordinary Portland cement (OPC) for non-structural applications[1]. This is of great significance when one considers that concrete made from OPC is the second largest commodity most used by communities across the globe. There are currently several countries with pilot or demonstrated geopolymerisation plants, and high-performance geopolymer concretes have been commercialized. The benefits of this technology in South Africa would be two-fold: (1) the recycling of highly problematic gold tailings to useful and valuable commercial-grade products; and (2) the prevention of acid mine drainage. In addition to the obvious economic benefits that would arise from this approach, this practice has a significant opportunity to reduce global carbon dioxide emissions.

The abundance of silicon and aluminium in starting materials used for geopolymerization is a prerequisite for the synthesis of high-quality geopolymeric materials. Most South African gold mine tailings are characterized by silicon:aluminium ratio varying between 3.0 and 11.0, which are similar to those of e.g. vanadium and copper mine tailings investigated abroad for this purpose[2]. Tailings from Klein Letaba exhibit particularly promising composition, but most tailings from Nestor mine exhibit very limited potential for geopolymerization because of their elevated SiO_2 content (up to 94.7%) combined with very low Al_2O_3 content (as low as 2.1%)[3]. The tailings also exhibited mineralogical analogies with overseas tailings, such as the predominance of quartz. It is important to test whether the abundance of quartz in gold tailings could impair the formation of high-quality geopolymers.

This paper will present the results of a preliminary screening exercise to assess the potential suitability of gold tailings from different mines as aluminosilicate sources for geopolymer synthesis. It will also present a thermochemical process whereby the quartz component of gold tailings can be successfully converted to water-soluble silicates. Optimised temperature, time and solid-to-solid ratio conditions resulted in >95% silica extraction from quartz within 1h. This pre-activation step may be a prerequisite for the utilization of gold tailings in geopolymer synthesis.

References:

[1] VickRoads (2010) Standard Specification Section 701, General Concrete Paving
[2] Jiao X et al. (2013) Construction and Building Materials 38, 43-47
[3] Novhe O and Lusunzi R (2014) CGS open access report, 23