STABILIZATION OF SULPHIDIC MINE TAILINGS WITH MGO ACTIVATED BLAST FURNACE SLAG

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The mining industry is the biggest producer of waste materials in the form of waste rock and tailings. Tailings ponds create potential ecological risks due to hazardous substances the tailings themselves and the toxic additives used in the metal processing phase include (1). For example, in China, tailings storage is rated to be 18/93 among the most dangerous environmental risk sources (2). Serious environmental accidents worldwide, increased public awareness and increasingly stringent environmental regulations have promoted research to develop new innovative approaches to mitigate the risks caused by tailings.

The Pyhäsalmi mine in Finland is one of the largest massive sulphidic ore mines in the world. The tailings potentially generate acid, mostly due to oxidation of iron sulphides (58 %). The total area of the tailings ponds is 150 ha which has mainly been covered with conventional methods at the beginning of the millennium. The mine will be closed in the near future, and the principal aim of the tailings recovery plan is to decrease environmental risks in the long-term by restricting acid generation caused by water and oxygen ingress. Several tailings pond cover liner options are currently under consideration. This study compares tailings stabilization with two alternative binder materials; alkali activated blast furnace slag (AAC) and Portland cement (PC).

Stabilization is a commonly used technology to prevent the leaching of hazardous substances into the natural environment. Stabilization encapsulates hazardous substances both chemically and physically. In the research, MgO-activated blast furnace slag was compared with PC as a stabilization binder using a dosage of 10 w%. According to the literature, MgO activated BFS binder has not been studied or used earlier in the stabilization of tailings while PC is the most commonly used stabilization binder.

However, the long-term durability of PC, especially in highly sulphidic environments, is questionable due to its vulnerability to sulphate attack and ecological impacts. These vulnerabilities are significant due to the need for high binder amounts and consequently required investments. In addition, commonly used liquid alkali activators, for example sodium and potassium hydroxides and silicates, have safety, cost and ecological issues.

In this research, by-product based MgO was used as an activator in BFS instead of liquid alkali activators. The laboratory studies tested hydraulic conductivity, compression strength, oxygen diffusion, leaching, freeze-thaw resistance and water resistance, in addition to chemical, mineralogical, microscopic and thermal analysis. The Life Cycle Assessment (LCA) method was used to compare environmental impacts of the used binder materials. A stabilized tailings layer with a thickness of 300 mm was constructed as a part of the advanced hardpan cover pilot structure of 100 m^2 in the tailings pond area.

According to the tests, the hydraulic conductivity (6.08E-09 m/s) and compressive strength (11.5 MPa/28 days) of AAC were better than when using the corresponding amount of PC (2.04E-08 m/s and 10.3 MPa/28 days) indicating better immobilization efficiency and thus improved technical performance, in addition to competitive costs. LCA shows clear ecological benefits when using AAC instead of PC: a 35 % lower amount of generated greenhouse gas emissions due to the use of waste based binders. In addition, using the stabilization method in tailings storage reduces the need for natural moraine in the cover structure. The video script illustrates the use of AAC binder in the pilot structure.

References

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