ALUM SHALE - PERMANENT STABLE DEPOSITION IN GYPSUM SLURRY

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Abstract

Alum shale is a sedimentary rock abundant in the Oslofjord Region deposited about 500 million years ago. Due to its nature, contents of sulfide (pyrite, FeS$_2$) and heavy metals (i.e. Cd, Cu, Ni, Zn, As, U and Hg) a number of problems can arise when exposed to air and oxygen-rich water, which frequently are the case at construction sites and open landfills. The sulphide is oxidised to sulphate and releases protons which in turn facilitates dissolution of heavy metals, leading to pollution of recipients affecting the local biota. The oxidation process is exothermic to such an extent that self-ignition may result. Additionally the presence of calcium forming Ca-sulfates can lead to swelling pressures causing problems during or after building construction (Norwegian Geotechnical Institute, NGI). The content of radioactive uranium is also a challenge, especially regarding radon gas (Rn) posing a health hazard in cellars and ground floor in areas rich in alum shale (Stranden & Strand).

The real estate business and remediation projects in the Oslo Region generate a surplus of polluted soil and alum shale. Consequently when alum shale is encountered it frequently has to be stabilised or removed for permanent deposition. The island of Langøya in the Oslofjord, operated by the company NOAH AS, is the only landfill that allow for a safe disposal of alum shale. NOAH’s permission from the Norwegian pollution authorities (Climate and Pollution Agency, Klif) allows treating of one million tonnes of inorganic waste per year, equally divided between hazardous and non-hazardous waste, of which 50.000 tonnes/year can be alum shale.

NOAH has treatment facilities for neutralizing flue gas residues (FGRs) from municipal waste incineration and waste sulfuric acid from the production of ilmenite. FGRs contain calcium oxide (CaO) and calcium carbonate (CaCO$_3$) originating from the gas purification processes. Calcium in FGR forms together with sulphate (SO$_4$) from the sulfuric acid, gypsum - calcium sulfate hydrate (CaSO$_4$·(H$_2$O)$_x$) (Klein and Hurlbut) which is deposited as a slurry and left to settle. The waste sulphuric acid also contains substantial amounts of iron, and the Fe$^{2+}$/Fe$^{3+}$ equilibrium provides a stable reducing environment for safe disposal of Alum shale. Alum shale deposited within the gypsum slurry thus constitutes an integral structural part of the landfill. Any metals present in the alum shale, or other inorganic waste, are stabilised. Reject water are continuously treated and analysed for pollutants safeguarding the method employed. Alum shale received at NOAH Langøya is permanently and safely eliminated from the environment.

References