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Assessing the sustainability of acid mine drainage (AMD) treatment in South Africa

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ABSTRACT:

The environmental sustainability of acid mine drainage (AMD) treatment at semi-industrial scale is examined by means of the life cycle assessment (LCA) methodology. An integrated process which includes magnesite, lime, soda ash and CO_2 bubbling treatment was employed to effectively treat, at semi-industrial scale, AMD originating from a coal mine in South Africa. Economic aspects are also discussed. AMD is a growing problem of emerging concern that cause detrimental effects to the environment and living organisms, including humans, and impose on development, health, access to clean water, thus also affect economic growth and cause social instability. Therefore, sustainable and cost effective treatment methods are required. A life cycle cost analysis (LCCA) revealed the viability of the system, since the levelized cost of AMD treatment can be as low as R112.78/m^3 (€7.60/m^3 or $9.35/$m^3$). Moreover, due to its versatility, the system can be used both at remote locales, at stand-alone mode (e.g. using solar energy), or can treat AMD at industrial scale, thus substantially improving community resilience at local and national level. In terms of environmental sustainability, 29.6 kg CO_{2eq} are emitted per treated m^3 AMD or its environmental footprint amount to 2.96 Pt/m^3. South Africa's fossil-fuel depended energy mix and liquid CO_2 consumption were the main environmental hotspots. The total environmental footprint is reduced by 45% and 36% by using solar energy and gaseous CO_2, respectively. Finally, AMD sludge valorisation, i.e. mineral recovery, can reduce the total environmental footprint by up to 12%.