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A hybrid and stepwise approach using a combination of MgO-NPs and a series of constructed wetland planted with *Vetiveria zizanioides* for the treatment of acid mine drainage

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An efficient, environmentally friendly and low cost hybrid approach was duly developed for the treatment of acid mine drainage (AMD). The hybrid approach combined a nano-and-biotic system operating in a step-wise modular. Specifically, the treatment chains were made up of different stages of which, stage 1 focused on activated magnesite for the neutralisation of AMD and stage 2 focused on the polishing of product water using a series of constructed wetland (CWs) planted with *Veteveria zizanioides*. In stage 1, raw AMD was treated with magnesite at a ratio of 1:100 (1g/100 mL), at 500 rpm, and 1 h of hydraulic retention time (HRT) whilst in stage 2, the pre-treated water was explicitly fed into the phytoremediation system for polishing of product water using a series of CWs planted with *Vetiveria zizanioides* in subsurface vertical flow (SSVF-CW), free water surface flow (FWS-CW) and subsurface horizontal flow (SSHF-CW) mode. In this stage, the product samples were characterised every 24 h per 5 days' interval for a period of 30 days. The feed and product sludge and plants were characterised using the state-of-art analytical techniques. Overall, the removal efficiency of chemicals species registered the following sequence, Fe (99.8%) ≥ Al (99.5%) ≥ Mn (99.24%) ≥ Zn (98.36%) ≥ Cu (97.38%) ≥ Ni (97.7%) ≥ SO_4^{2-} (80.59%). The electrical conductivity (EC) recorded ≥ 86%. The pH was observed to increase from 2.9 to 10.2. Thenceforth, the substrate, grass and external factors played a huge role in residual chemical species removal. The PH REdox EQuilibrium (in C language) (PHREEQC) geochemical model confirm that metals existed as di-and-trivalent complexes in solution.
Keywords: Acid mine drainage, hybrid approach, MgO-nanoparticles