Mine-water quality at a tertiary coalfield in India: Characterisation and treatment using novel polyvinyl alcohol (PVA) gel bioreactor

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Nearly 78 percent of the total measured (proved) tertiary coal reserves of India is concentrated in the north-eastern state of Assam. The Tertiary coal of North–Eastern Coalfields (NEC) has been found to contain as high as 8% sulphur with varying percentage of pyrite, sulfate, organic and free sulphur. The pyrites are often associated with toxic heavy metals. Acid mine drainage (AMD) is generated when mining activities expose the pyrite and sulfides to atmospheric oxygen, moisture and micro-organisms that catalyse the oxidation process to release large amounts of sulfate into the mine water along with protons and dissolved metals. Microbial dissimilatory sulfate reduction (DSR) in the presence of a suitable organic carbon source can be engineered to treat such water. This study is significant because this region is rich in biodiversity and such mining impacted water may have adverse ecological impact, if discharged without appropriate treatment.The objective of the work is to characterise water samples collected from two open cast mines of Makum coalfield under NEC and evaluate the performance of a novel polyvinyl alcohol (PVA) gel packed bed bioreactor to treat the same. Sample collection, storage and physico-chemical analysis are carried out as per Standard methods of American Public Health Association. The biological treatment process is studied in a cylindrical continuous flow lab scale bioreactor under relevant acidic pH at different feed chemical oxygen demand (COD) to sulfate ratio and hydraulic retention time (HRT). Sludge from a lab scale anaerobic bioreactor treating very high sulfate industrial water is used as inoculum. The sulfate reducing microorganisms are enriched within the bioreactor in fed-batch mode using modified Postgate’ s medium for one month.Oxidation Reduction Potential (ORP), pH, sulfate removal, total inorganic carbon (TIC) and alkalinity produced are measured at the bioreactor outlet to evaluate the process performance. The mine water samples exhibit low pH, high sulfate, conductivity, dissolved solids, hardness, iron and manganese, which indicates the occurrence of AMD. The treatment process reduces the sulfate concentration and increases pH of the treated water. The use of highly porous PVA gel beads as packing material in the bioreactor treating sulfate rich acidic water imparts resilience to operational variation. The study evaluates the novel application of PVA gel beads to bioreactor for treating acidic mine waters from an ecologically important region. The research finding provides an understanding of the process for application to other biological AMD treatment configurations.

Keywords: acid mine drainage (AMD), polyvinyl alcohol (PVA), sulfate, sulfate reducing microorganism (SRM), dissimilatory sulfate reduction(DSR), pyrite

