

Evidence

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Mitigation of pollution from abandoned metal mines literature review

Project summary SC090024/S1

Waters draining from abandoned metal mines pollute many rivers in England and Wales and prevent these rivers from achieving 'good ecological status' under the European Water Framework Directive. A new report commissioned by the Environment Agency and Department for Environment, Food and Rural Affairs (Defra) summarises the current treatment options for mine waters that avoid the need for large amounts of chemicals and energy. Reviews of passive treatment technologies for the remediation (clean-up) of metal mine water discharges, and metal recovery options from such systems, have identified a wide range of treatment systems and the potential to produce material resources or non-hazardous wastes from them by means of various technologies.

Treatment systems for metal mine drainage can encompass a variety of processes, but they all aim to immobilise metals within the confines of the system. Both pH and redox potential (Eh) are key controls on the geochemical behaviour of metals in aqueous environments and so are important parameters to consider when designing a water treatment system. Precipitation of hydroxides is a common approach to treat coal mine drainage, under conditions of near-neutral pH and elevated Eh. However, this is far less effective for metal mine drainage. A more favourable approach to immobilising metals such as zinc and cadmium in metal mine drainage, at the pH values typically achievable in passive treatment systems (up to a pH of 8), appears to be the use of anaerobic systems which harness bacterial sulphate reduction. These systems use mixtures of compost, sewage sludge and limestone (or similar media) to encourage the formation of metal sulphides and lead to very low metal concentrations in the effluent.

However, in most cases residence times still tend to be too long (several days) for these systems to be realistically feasible in UK settings, since the systems would take up too much land. Identification of potential carbon additives and sources of microbial inocula are essential to maintain bacterial sulphate reduction at sufficient rates to immobilise metals in a reasonable timeframe.

Pilot-scale testing is needed to establish the performance of such enhanced systems in field conditions.

In terms of resource recovery options from passive systems treating metal mine discharges, metals accumulate in passive treatment systems but rarely to economic mineral cut-off grades. Usually metal accumulation in the substrate is heterogeneous. Metal recovery may be possible in some cases, but may not be a widely feasible option.

The materials generated by passive treatment systems may be considered hazardous wastes, potentially making disposal to landfill very expensive. Chemical and biological leaching (either for metal recovery or decontamination) technologies are the most cost-effective options for metal removal from low-grade treatment substrates, and may therefore be the best way to overcome this problem. At larger scales leaching to recover metals may not be feasible, in which case stabilisation or solidification, in an attempt to restrict the movement of contaminants, may be a possibility.

The type of passive treatment system chosen to remove the metals will have an impact on the potential to recover these metals from the substrates of these systems. The wide range of organic and mineral substances within the different treatment systems will also have an impact on the potential to recover metals, and also the outcome of leachability tests which determine the classification of any waste arising from the system.

Other options for recovering resources from passive mine water treatment systems include ground source heat and micro-hydroelectricity. Only the former has been tested in the UK (on coal mine waters), though the technologies for the latter are well established.

A common conclusion to both reviews is the need for pilot-scale experiments to establish the performance of different passive remediation technologies for metal mine drainage under field conditions and to determine metal recovery/decontamination efficiencies from substrates.

The passive treatment technologies review shows that it is feasible to immobilise metals, using various processes, at the laboratory scale but few studies have been undertaken at pilot or full scale. Similarly, with regards to resource recovery, few studies have investigated the recovery of metals from pilot or full-scale systems but technologies have been proven on other wastes. The next step, therefore, is to investigate both remediation processes and resource recovery technologies at pilot scale.

This summary relates to information from project SC090024, reported in detail in the following output(s):

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