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A Sustainable Approach for Acid Rock Drainage Treatment using Clinoptilolite

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Problems related to acid rock drainage (ARD) occur along many highways of British Columbia. The ARD problem at Pennask Creek along Highway 97C in the Thompson-Okanagan region is an ideal site for pilot study to investigate a possible remediation solution. The highway was opened in 1991. An ARD problem was identified in 1997. Both sides of Highway 97C are producing acidified runoff from both cut rock surface and a fractured ditch. This runoff eventually enters Pennask Creek, the largest spawning source of rainbow trout in British Columbia. The current remediation technique using limestone for ARD treatment appears to be unnecessarily expensive, to generate additional solid waste and to not be optimally effective. A soil mineral natural zeolite – clinoptilolite – which is inexpensive and locally available, has a high metal adsorption capacity and a significant buffering capacity. Moreover, the clinoptilolite materials could be back-flushed and reused on site. An earlier batch adsorption study from our laboratory demonstrated that clinoptilolite has a high adsorption capacity for Cu, Zn, Al, with adsorption concentrations 131, 158 and 215 mg/kg clinoptilolite, respectively, from ARD of pH 3.3. Removal of metals from the loaded clinoptilolite by back-flushing was found to depend on the pH, with an optimum pH range for extraction of 2.5 to 4.0 for a contact time of one hour. The rank of desorption effectiveness was EDTA $>$ NaCl $>$ $NaNO_3$ $>$ NaOAC $>$ $NaHCO_3$ $>$ Na_2CO_3 $>$ NaOH $>$ $Ca(OH)_2$. A novel process involving cyclic adsorption on clinoptilolite followed by regeneration of the sorbent by desorption is examined for the removal of heavy metals from acid rock drainage. Experimental results show that the adsorption of zinc and copper depends on the pH and on external mass transfer. Desorption is assisted by adding NaCl to the water. A slurry bubble column was able to significantly reduce the time required for both adsorption and desorption in batch tests. XRD analysis indicated that the original structure of the sorbent is retained over multiple adsorption/ desorption cycles. Clinoptilolite in a slurry bubble column appears to be a promising sorbent for treatment of ARD leachate.