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Mine-water treatment study proposes new solution

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A study carried out by Dr **Olaf Pollman** of the North-West University's School of Environmental Science and Develop-ment offers a new way of treating heavily polluted mine water containing high levels of heavy metals and other undesirable elements.

"The aim of the project was to use a totally different method to clean the highly polluted acid mine drainage (AMD) in underground water in an organically biochemical and mechanical way," Pollman says.

AMD results from mining activities exposing water to elements such as iron, sulphates, manganese, mercury, zinc, copper and nickel. Under normal circumstances, operational mines pump this water out of the underground workings to dewater underground mining operations. This water may then be released into the unpolluted groundwater used, through boreholes, for agriculture and for human and animal consumption. Polluted water from mines may also find its way to rivers and streams.

The new technology proposed by Pollman uses only organic materials and organic and biosystematic processes precipitate the heavy metals out of the system.

Pollman explains that the method of deal- ing with AMD depends on different cleaning steps. First the organic material intended to clean AMD is moistened to open the plant cells in preparation for the process. After the material has been left for a few days, the AMD, which is highly polluted with trace elements, such as calcium, magnesium, potash, sodium, iron and chloride, is run through the different sacks filled with bark and needles.

The precipitation is then visible on top of the sacks filled with a mixture of needles and bark from the *Casuarina* pine species. In this way, the metals and salts removed from the water may be reused in different processes.

“In the case of the laboratory experiment, three cylinders were filled with different materials. “The first was filled with a 50% mixture of the bark and needles of the pine species. The materials contained organic composites, such as bacteria, fungi, yeast and other micro organisms. The other 50% was filled with sand. “The second cylinder only contained bark and sand and the third contained needles and sand. This arrangement made it possible to see which

material combination was best suited to precipitate the elements out of the AMD," Pollman explains.

To make the cleaning process even clearer, the polluted water was recycled through the system more than ten times. After every cycle, samples were taken from each cylinder to measure the pH and the total iron (Fe) content.

After full recycling, the water was tested for macro-, micro, and other elements by water and 1 to 2 extract analysis.

"The process of cleaning the AMD entails leading the water through all the cylinders filled with the organic filters and reaction materials. "In this case, 5 l of the AMD was filled in the first cylinder and, after leaching through the material, the AMD was pumped to the next cylinder. "After passing through all three cylinders, the cleaned AMD was pumped back to the first cylinder to pass through the system again. This was repeated more than ten times," Pollman says.

To test field conditions, the AMD was led over a testbed of cascades, which was also filled up with different materials. The first cascade was filled with needles and bark, the second with bark and sand, and the third with only needles and sand. Finally the AMD had to pass a cascade of the sedimentary rock, dolomite.

The conditions in the laboratory were transferable to field conditions and, consequently, the results were comparable to the boundaries as limited by field conditions. The circulation of the AMD water through the cylinders showed that the pH rose when treated with semi- decomposed organic material and that the metals were bound and precipitated to the surface. The treatment of the AMD water in the cascades also showed that Fe can be bound and removed from the water. As a result of oxidation and rain water, the pH still remained low. The results of this test indicate that the natural treatment of the heavy metals by the capillary pressure of the pine needles and bark is working well.

The results attained in the laboratory experiment as well as the AMD treatment after only 30 days shows that the reaction of the semidecomposed organic material, named SupaZorb, binds and immobilises the heavy metals and that the natural protection of the pine needles and bark through capillary reaction can precipitate the metals to the surface.

The lignin and tannin of the bark also raised the pH of the AMD and supported the precipitation of metals.

“The removal of metals is not finally combined with the rise of pH in the AMD water. The results of both experiments prove a removal of metals of more than 80%. “In addition, the water quality improved to such an extent that algae and zooplankton could be detected in the treated AMD water,” Pollman says.

"To raise the pH of the system, the oxygen balance must be corrected through a process such as ozonation, the system must be covered from extreme rainfall and the sulphates have to be removed. "To finalise the project, the cascades only have to be stabilised and optimised to the ever-changing conditions on site," Pollman concludes.

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