WATER RESEARCH COMMISSION

October 2013
The WRC operates in terms of the Water Research Act (Act 34 of 1971) and its mandate is to support water research and development as well as the building of a sustainable water research capacity in South Africa.

TECHNICAL BRIEF

Nanotechnology

Nanotechnology in water treatment

A WRC-funded study has investigated the use of integrating selected nanomaterials for the treatment of contaminated water.

Nanotechnology

Technological drives to push current boundaries and intrinsic needs to overcome modern problems associated with sustainable economic growth along with associated environmental problems provided the momentum for this WRC-funded project, which undertook experimental work to ascertain the effectiveness of integrating selected nanomaterials into six different remediation strategies for the treatment of model and real contaminated water samples.

The work was undertaken over a period of three years in a collaborative effort between researchers at the universities of the Western Cape, Stellenbosch KwaZulu-Natal and the Cape Peninsula University of Technology. Research focused on the removal of several inorganic and selected organic contaminants, with an emphasis on polluted water that is highly likely to be found within South Africa. Specifics included acid mine drainage from various mines in Gauteng and Mpumalanga regions, industrial brine effluents, dyes and bacteria laden water.

Three main tasks of the study

From a technical point of view, the work was subdivided into three tasks, whereby a selected technology, process or adsorbant was adapted and implemented to remediate a specific type of polluted water.

Firstly, natural adsorbents, clays and zeolites were selected as a low cost material for the treatment of contaminated water. After the natural zeolite underwent mild activation steps it was shown to be effective in removal of ammonia from model solutions and reducing the salinity of industrial brines, with some minor leaching of undesirable heavy metals. The inhomogeneity of the natural mineral deposit could affect its adsorption capacity.

This was followed by novel research into whether zero-valent nano-iron could be used to treat acid mine drainage. The research produced positive results, which indicated that not only could zero-valent nano-iron successfully treat the heavily contaminated water, but a one-step process (Where the acid mine drainage is the source of iron) was the most effective treatment option. It was also discovered that ordered mesoporous carbons were very effective as mercury sorbents after being modified with suitable functional groups.

In addition, an electrohydraulic discharge reactor that can incorporate supported titanium dioxide nanofibres was shown to be extremely effective in the complete demineralisation of dyes, and complete disinfection of ***E.Coli*** spiked waters.

This work has been patented and the invention relates to a water treatment apparatus that employs ultraviolet radiation and ozone for the purpose of directly and indirectly killing potentially harmful biological species in the water. UV radiation emanating from the electrohydraulic discharge electrode impinges on the photocatalyst to activate it and cause it to promote photocatalytic reactions within the water which promote the formation of OH radicals that attack organic pollutants and break them down into water and carbon dioxide.

Finally, a chemical vapour deposition method was used to synthesize titanium dioxide nanoparticles supported on carbon nanotubes. The results show that silver nanoparticles deposited on the titanium dioxide act as electron acceptors, thereby enhancing the charge separation of the electrons and holes. This leads, in turn, to a transfer of the trapped electrons to the adsorbed oxygen during UV radiation.

In summary

In summary, zero-valent nano-iron, zeolites, ordered mesoporous carbons, electro-deionization, an electrohydraulic discharge reactor and chemical vapour deposition were investigated and each was found to show great potential as an effective means to treat select industrial wastes. Some of the technologies were general oxidation processes and others were excellent for specific pollutants.

Further reading:
To order the report, ***Nanotechnology in water treatment*** (**Report No. 1897/1/12**) contact Publications at Tel: (012) 330-0340, Email: orders@wrc.org.za, or Visit: www.wrc.org.za to download a free copy.