Small Water Systems

their management and opera-

CRC for Water Quality and Treatment

In this edition...

Investigation into scale mitigation measures for hard groundwaters

Nerida Beard, Centre for Appropriate Technology

The Centre for Appropriate Technology recently completed phase one of a study on the effectiveness of the 'Calgon' (a polyphosphate namely sodium hexametaphosphate) dosing agent in reducing scale accumulation in hot water systems.

The majority of communities in central Australia rely on groundwater aquifers as the primary source for the water supply. Groundwaters can contain high concentrations of dissolved minerals that reduce the functional life and increase the infrastructure maintenance requirements, such as water systems, hot water systems and air conditioners. In some cases, hard waters cause the failure of key health hardware, impacting on the health of residents.

The are a number of options available to minimise the impacts of scale including source substitution (use of rainwater or surface runoff), dosing with ameliorating water additives (lime, polyphosphates, soda ash, caustic soda) or by using size-separation or molecular processes (reverse osmosis, ion exchange). While source substitution is the preferred option, alternative sources may not be available or economic to develop and treatment may need to be considered. However, treatment systems are difficult to administer and maintain in the context of many remote communities.

Above: Project researcher Nerida Beard and community Essential Services Officer, Norman Hagan.

Over the last 60 years, polyphosphates have been touted as a simple method to prevent scale and are utilised widely in the United States for a range of other water quality management issues including reducing the release of copper and lead. However, their performance varies widely depending on the quality of the water and there are limited studies demonstrating the successful use of polyphosphates with hard water with high alkalinity, similar to those utilised in many central Australian communities.

Investigation into scale mitigation measures for hard groundwaters (cont)

A trial of the polyphosphate, sodium hexametaphosphate, in a remote community in Central Australia provided an opportunity to monitor rates of scale accumulation under the influence of the treatment. The mass of scale accumulation was monitored on two solar and five electric hot water system elements in seven households over a 15-month period and the cumulative mass analysed against hot water use. The five electric hot water system elements monitored recorded measurable rates of scale accumulation throughout the monitoring period. Despite comparatively higher water use in the two solar hot water systems, scale accumulation on these elements was barely measurable, which was attributed to the different material characteristics of the elements.

Above: Community ESO Norman Hagan reads a flow meter on a hot water system.

The effectiveness of sodium hexametaphosphate is greatly reduced in areas of low flow throughput, as was the case in the electric hot water systems. Sodium hexametaphosphate effectiveness is also influenced by pH, dissolved oxygen, temperature and changes in mineral concentrations in bulk water.

Monitoring for Phase 2 of the study will cease in July 2007, and will provide baseline data from which to compare and ascertain the effectiveness of sodium hexametaphosphate as a mitigation measure for calcite scaling in hard groundwaters.

This project was funded by the Northern Territory Department of Planning and Infrastructure , Indigenous Essential Services Division, and through ongoing program funding from the CRC Water Quality and Treatment's Regional and Rural Water Supply Program. The project was delivered through the Water Technology Transfer Officer for water supply in Indigenous communities, based at the Centre for Appropriate Technology.

Above: Calcite scale build-up on an electric hot water system element.

For a copy of the Phase One research report please telephone 08 8951 4311, or email nerida.beard@icat.org.au.

Investigation of Defluoridation of Water Supplies in Rural and Remote Communities

Amy Dysart, Power and Water Corporation

Power and Water Corporation and the CRC for Water Quality and Treatment recently completed the first stage of a two-year project to investigate the options available to remove fluoride (defluoridation) from drinking water supplies in rural and remote communities.

The project aims to identify a cost effective, robust and low maintenance defluoridation system that may be implemented in these rural and remote communities.

Fluoride primarily produces effects on skeletal tissues (bones and teeth) and has a narrow range between intakes that cause beneficial and detrimental health effects. Elevated levels of fluoride (>1.5 mg/L) in the drinking water occur in a number of parts of the world and often have significant adverse impacts on public health. In the Northern Territory elevated levels occur in a limited number of groundwater supplies, resulting in an increase in the prevalence of dental fluorosis in the affected populations.

Initial research into the techniques available to defluoridate groundwater identified that those based on the principals of sorption were most suited to rural and remote locations. Sorption based defluoridation systems rely on the removal of fluoride by providing contact between the water (containing the fluoride) and media (which binds the fluoride). The systems are relatively simple requiring a reactor vessel to contain the media (typically a column), which once it is exhausted can be regenerated or replaced. Activated alumina, bauxite and hydrotalcite where identified as potential media that may be effective at removing fluoride from natural groundwater that occurs in the Northern Territory with elevated fluoride concentrations around 2.5 mg/L at a pH of 7.5.

Batch adsorption experiments utilising activated alumina, bauxite and hydrotalcite demonstrated sucessful removal of fluoride from the natural water samples. Activated alumina displayed the highest removal rate, greatest capacity for fluoride and the smallest impact on the other water quality characteristics. Therefore activated alumina was utilised for further equilibrium isotherms and column studies.

The activated alumina equilibrium isotherms were correlated to the Langmuir and Freundlich equations indicating that an appropriate level of fluoride adsorption from natural waters could be achieved. While equilibrium isotherms are useful in providing an indication of the performance of the adsorption media under static test conditions, they do not give accurate scale up data in a fixed bed system. In order to ensure successful practical applicability of the activated alumina additional column studies are required to evaluate the performance of the systems in continuous flow system.

The column studies were carried out using water from two communities in the Northern Territory, Tennant Creek and Ali Curung, which recorded

Investigation of Defluoridation of Water Supplies in Rural and Remote Communities (cont)

fluoride adsorption capacities of 875 mg/kg and 1268 mg/kg respectively. While, the equilibrium isotherms underestimated the adsorption capacity of the activated alumina, the column studies correlated closely with previous investigations and confirmed the capacity of activated alumina in a continuous system.

As part of the column studies, regeneration (and reactivation) of the column was carried out using 0.1 M NaOH and 0.1 M HCl. Revealing that the fluoride removal efficiency following regeneration decreases with increasing number of regeneration cycles, although the loss of capacity decreases with the number of regeneration cycles.

Above: Laboratory trial of activated alumina deflouridation column

The feasibility of implementing a pilot plant to treat the drinking water at Ali Curung included a comparison of the activated alumina system, operated with either media replacement or regeneration, with a reverse osmosis system and providing alternative water (carted).

The activated alumina system is relatively cost effective, especially compared to the reverse osmosis, although treatment with the reverse osmosis system removes a number of contaminants to improve the overall quality of the water compared to the activated alumina, which specifically removes fluoride. The supply of alternative water (carted) initially performs competitively, although over the long term this option is relatively more expensive. Over the long-term the activated alumina system with regeneration is the most economical, however the activated alumina system with media replacement is competitive, considering the lower initial capital investment and the significantly lower system complexity. Therefore, operating the activated alumina system with media replacement is the preferred system, although if a number of activated alumina systems were to be implemented, then the construction of a central regeneration location would be more favourable.

Stage 2 of the project will consider the options for the construction of a pilot plant at one of the communities in the Northern Territory over the next twelve months based on the laboratory trials and feasibility.

For further information or a copy of the research report, please contact Amy Dysart on 08 8914 5064 or e-mail on amy.dysart@powerwater.com.au

The CRC Associates are:

Barwon Water
Central Highlands Water
Coliban Water
Cardle Coast Water
Department of Sustainability and Environment (Vic)
Department of Natural Resources, Energy and Mines (Qld)
Environmental Protection Agency Queensland
Esk Water
GHD Pty Ltd
Gippsland Water
Gold Coast City Council
Goulburn Valley Water
Goulburn-Murray Water
Grampians Wimmera Mallee Water
Hunter Water Corporation
Lower Murray Water
Pine Rivers Shire Council
South East Queensland Water Corporation
Sustainable Water Solutions, Department of Commerce (NSW)
Townsville Thuringowa Water Supply Board

Contributions

The newsletter is produced on a quarterly basis. Feedback is welcome on all aspects of the newsletter and contributions are encouraged on what you are doing, how you are doing it and how well it's working or not. Contributions for the next edition should be forwarded to Amy Dysart by 15 July 2007. For more information please contact Amy Dysart on 08 8924 5064 or amy.dysart@powerwater.com.au

Regional and Rural Water Supplies

Program Coordinator

• The Regional and Rural Water Supplies Program recently initiated a new project, the Water Analysis Report for Small Systems (WARSS). The project aims to develop a software tool that allows small systems operators to load and store their water quality results and provide a visual graphical report of the results in terms of the ADWG recommended levels. The project primarily involves the development of a software tool to assist small communities in the interpretation of water quality results, which will be achieved through the engagement of an appropriate consultant and software development company. The Governing Board recently approved the project proposal and we are now looking for expressions of interest in the development of the project.

• Through the Regional and Rural Water Supplies Program, representatives from the state and Territory wide utilities in the Northern Territory, South Australia and Western Australia have formed a water quality forum. The specialised network is designed to maintain communication on water quality issues commonly encountered in the supply of water to a range of centres and communities across Australia. The first meeting was held in Adelaide late last year and the second meeting will be held in Darwin in late July 2007.

• On the 18 and 19 June the CRC for Water Quality and Treatment held their quarterly Management Committee and Governing Board meeting in Darwin. The event was hosted by Power and Water and including a short bus ride to enjoy the delightful Darwin climate and food at Pee Wee's Restaurant.

For more information on this please contact Amy Dysart on 08 8924 5064 or e-mail on amy.dysart@powerwater.com.au

The CRC Parties are:

ACTEW Corporation
Australian Water Quality Centre
Australian Water Services Pty Ltd
Brisbane City Council
Centre for Appropriate Technology Inc
City West Water
CSIRO
Curtin University of Technology
Department of Human Services Victoria
Griffith University
Melbourne Water Corporation
Monash University
Orica Australia Pty Ltd
Power and Water Corporation
Queensland Health Pathology & Scientific Services
RMIT University
South Australian Water Corporation
South East Water Ltd
Sydney Catchment Authority
Sydney Water Corporation
The University of Adelaide
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United Water International Pty Ltd
University of South Australia
University of Technology, Sydney
Water Corporation
Water Services Association of Australia
Yarra Valley Water Ltd