



New England Water Treatment Technology Assistance Center

University of New Hampshire • Durham, New Hampshire

PROJECT SUMMARY REPORT

Removing Radium-226 Contamination From Ion Exchange Resins Used in Drinking Water Treatment

Problem statement/objective

Improper cleaning of cation exchange resins used to remove naturally occurring radioactivity in groundwater limits the effectiveness to treat to drinking water standards, decreases the life expectancy and increases the amount of radioactivity in treatment residuals. The recent implementation of the Radionuclides Rule by the USEPA identifies a need to determine the most influential cleaning factors so that cleaning techniques may be modified so that cleaning conditions are optimized.

The specific objectives of this project include:

1. Determine the extent of radium-226 activity accumulating and possible irreversible fouling on cation exchange resins during average treatment conditions;
2. Assess the amount of radium-226 activity removed from the resin media during cleaning conditions by use of various regenerate solutions and contact times; and
3. Determine the effect exposure time, or contact time between the radium-226 ion and the resin surface, has on the radium-226 removal process during cleaning of resins with varying age and total cleaning cycles.

Methodology

A series of laboratory scale studies was conducted by treating groundwater with trace radium-226 activity using cation exchange resins and the resins were cleaned under varying cleaning conditions.

First, a site was selected in New Hampshire with recorded radium-226 levels above the drinking water standards. Columns treated groundwater from the site using two cation exchange resins. Hardness and radium-226 activity was monitored on raw and treated water to indicate when the resins were near exhaustion and there was limited treatment occurring (Objective 1).

Next, samples of exhausted resin used for treatment of groundwater containing high levels of radium-226 activity (Objective 1) were regenerated with prescribed brine cleaning solutions, pH, and contact time and analyzed for trends and indications of most

influential cleaning factors over a period of six months (Objective 2). The impact of mass loadings of salt on the resin cleaning process was also developed.

Finally, in order to compare resins of different age, resin samples were collected at two local drinking water treatment plants and cleaned using the optimized cleaning settings and evaluated (Objective 3).

Results

The results of this study confirmed that the concentration of salt in the brine cleaning solution was the most influential factor in the resin regeneration process. The combined factor settings of low brine pH, lengthy cleaning solution contact time, and short radium-226 to resin exposure time (time between cleanings) showed the best removals for radium-226. An increase in salt mass loadings during cleaning showed limited response in removals over 80%, suggesting irreversible fouling is possible.

Conclusion Summary

1. Extent of radium-226 activity accumulation and fouling:
 - High levels of radioactivity can accumulate on cation exchange resins during treatment of trace levels of radium-226 in groundwater source.
 - Radium-226 was removed concurrently with hardness before exhaustion.
 - Hardness breakthrough occurred before Radium-226 breakthrough and is a good indication of when the resin is near exhaustion.
 - The best removals under the cleaning conditions used in the laboratory and at the existing water treatment systems were unable to remove all radium-226 buildup, suggesting the likelihood of irreversible fouling.
2. Determine influential cleaning factors during resin regeneration.
 - Salt concentration in brine cleaning solution appeared to be the most influential factor.
 - Factor settings for other factors include:
 - Low brine pH
 - Lengthy cleaning solution time
 - Short radium-226 to resin exposure time
 - High salt mass loading on resins will increase removals; however, there is less increase in removals above 80%.
3. Determine the effect of radium to resin exposure time has on the cleaning of older resins.
 - Older resins with numerous regeneration cycles behave similarly to newer resins during regeneration and removals tend to be more influenced by salt mass loadings than age.

Recommendations

- Maintain high salt concentrations in brine cleaning solutions by keeping salt crocks full and water levels no higher than the salt level.
- Clean resins frequently to remove radium-226 buildup and lower radioactivity in resin waste residuals.

- Investigate removals associated with cleaning of mixed resins bed to treat for multiple radionuclides using optimized brine cleaning solution.
- Examine the health hazards associated with radon accumulation from resin wastes or media temporarily out of service.
- Improve waste characterization and clarify disposal criteria for radioactive residuals.

Presentations

- U.S. Environmental Protection Agency Radionuclide Workshop. Chelmsford, Massachusetts, April, 2007.
- New England Interstate Water Pollution Control Commission Drinking Water Administrators Workgroup Meeting. Lowell, Massachusetts, September, 2007.

Disclaimer

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