Tonka Technical Bulletin

Radium Removal
from Potable Water

TONKA EQUIPMENT COMPANY

Introduction

In December 2000, the Final Radionuclides Rule was published by USEPA with an effective date of December 8, 2003. This rule sets maximum contaminant levels (MCL's) for radioactivity from Gross Alpha, Beta-Photons, R-226 and 228, and uranium. The MCL for combined radium 226 and 228 was set at 5 pico-curies per liter (5pCi/L).

Utilities affected included ***all community water systems (CWS), regardless of size.*** USEPA anticipates that approximately 800 systems will have to install radium treatment, with annual compliance costs estimated at $81 million.

Background

The purpose of the Final Radionuclides Rule is to reduce the risk of cancer by reducing exposure to radionuclides in drinking water. The two radium isotopes identified to be of primary concern are radium 226 and radium 228, because of potential carcinogenic impact. The intent is also to increase health protection for the public by reducing overall environmental exposure to radionuclides. Radium by nature is unstable and is continually emitting energy in the form of daughter products. Many of these daughter products of radium are also public health concerns.

Radium contamination of groundwater is generally attributed to natural sources. Dissolved radium is found in many rock formations that affect drinking water. The areas where radium is present in public water supplies include the Midwestern US and the east coast.

Radium Removal

Radium is a divalent cation alkaline earth metal (as are calcium and magnesium). As such, radium behaves very much as calcium and magnesium do in water. Removal of calcium and magnesium in public water supplies entails softening, so it follows that the BAT's (Best Available Technologies) identified by USEPA for removal of radium are also softening techniques. Lime softening, ion exchange and reverse osmosis have all been identified as approved processes for radium removal. Unless softening is also a treatment goal for the water utility, these processes can be costly and unnecessary.

Community water systems are not restricted to BAT's to meet the radium MCL, so it is not necessary to soften to remove radium. Any technology that meets state primary agency approval, and also meets the MCL, is acceptable to USEPA. Other technologies that are particularly suited for small systems include preformed hydrous manganese oxide (HMO) addition, and removal in conjunction with manganese in iron and manganese removal processes. Both of these processes rely on the natural affinity of radium to be attracted to manganese oxide.

Tonka Equipment Company has significant experience in the use of many of the radium removal processes, having several installations in operation that are successfully removing radium from drinking water. A brief discussion of our cost-effective and easily adaptable technologies follows.

Tonka's Dualator® III - Suitable for Radium Removal

Tonka Manganese Coated Media Systems

Processes using manganese greensand or manganese oxide coated media are relatively inexpensive techniques for radium removal. Efficiencies up to 80% may be possible using this technology. As an additional benefit, if iron and manganese are present in the water supply, these contaminants are also removed. There are basically two mechanisms to remove radium in these processes: (1) co-precipitation and (2) contact oxidation.

In the co-precipitation process, the water supply either has sufficient naturally occurring manganese, or additional dissolved manganese is added. Potassium permanganate is then applied to convert the manganese to manganese oxide prior to filtration. The manganese oxide/radium complex forms a precipitate and is then filtered. Accumulated precipitate is periodically backwashed off the media during normal filter backwashing.

When there is insufficient manganese in the feed stream, dissolved radium will adsorb onto a manganese oxide media coating. Under this scenario, radium is not backwashed off, and may accumulate in the bed. This contact oxidization technique, although effective, is generally not recommended by Tonka because it carries a high potential for radium accumulation in the filter media. As radium or any other radionuclide degenerates, hazardous byproducts such as radon are emitted, so radium accumulation technologies should generally be avoided.

Tonka HMO Systems

HMO addition involves the preparation and controlled dosage of a preformed manganese oxide solution to raw water prior to filtration. Radium is adsorbed on the surface of the added HMO particles, which are subsequently filtered. ***Numerous pilot studies conducted by Tonka indicate that radium removals of over 90% can be achieved with proper HMO pre-treatment.*** As an added benefit, high percentages of Gross Alpha and Gross Beta radioactivity are usually removed by the HMO process.

Filter media used for HMO can be silica sand/anthracite dual media or manganese oxide coated media. Radium not adsorbed and removed with the HMO particle will adhere to coated media and accumulate. For this reason, silica sand/anthracite media beds are preferred and strongly recommended by Tonka. As with manganese coated media, iron and manganese also present in the water will be removed in the HMO process.

Tonka Ion Exchange Systems

Cation exchange can effectively reduce radium levels by over 90%. The water is necessarily softened in the process – a potential side benefit if the source water is hard. In this technology, the radium and hardness are exchanged with sodium, and the resin is regenerated based on hardness capacity.

Because most of the hardness is removed in the ion exchange process, a very aggressive water condition results. To render the finished water less aggressive, a percentage of the raw water is usually bypassed and blended with the ion exchanged water. The blended finished water is therefore higher in radium than the water that is processed by the ion exchanger, and the overall radium removal efficiency generally is lower because of this. Thus, cation exchange treatment is most suitable for waters with moderate radionuclide content that need softening.

Tonka Experience

Tonka Equipment Company has broad experience in HMO technology using both specialized dual media and manganese oxide coated media. Tonka has also manufactured several full-scale facilities that effectively remove radium using ion exchange, manganese oxide coated media and HMO technology.

Call your Tonka representative for more information on radium removal or any other water treatment challenge.

References:

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6. Internal Tonka database of independent lab testing from water treatment plant pilot studies and full scale plant.

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