http://cfpub.epa.gov/safewater/radionuclides/radionuclides.cfm?action=Rad_Reverse%20Osmosis

EPA United States Environmental Protection Agency

Radionuclides in Drinking Water

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Learn

Reverse Osmosis

Reverse osmosis is a pressure-driven membrane separation process. Water is forced through a membrane with small pores by pressures ranging from 100 to 150 psi. Any molecules larger than the pore openings are excluded from the product stream along with a significant portion of the water. Treated water is collected on the other side.

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Benefits

Reverse osmosis has been identified by EPA as a Â¿best available technologyÂ¿(BAT) and Small System Compliance Technology (SSCT) for uranium, radium, gross alpha, and beta particles and photon emitters. It can remove up to 99 percent of these radionuclides, as well as many other contaminants (e.g., arsenic, nitrate, and microbial contaminants). Reverse osmosis units can be automated and compact making them appropriate for small systems.

Limitations

Membrane failure, which can allow contaminants to pass through to the finished water, is a key concern. For this reason, systems will need to perform membrane integrity testing. Direct methods measure the integrity of the membrane and its housing through either pressure drop or markers and usually require taking the unit offline. Indirect methods can be performed while the unit is on-line. These methods involve continuously measuring parameters in the effluent such as total dissolved solids (TDS), turbidity, or particle counts. Even if indirect measurements are taken on a continuous basis, direct integrity measurements should be taken periodically. Consult with the manufacturer for guidelines on how often to perform these tests. Because of the necessity of performing integrity tests as discussed and the need to maintain operating parameters such as pressure, reverse osmosis requires some advanced operator training.

The high pressure required for reverse osmosis means higher energy and capital costs for the membrane units. This can be significant compared to other technologies, making reverse osmosis one of the more expensive treatment options. In addition, reverse osmosis units lose a large amount of the influent water in the reject stream (between 10 and 70 percent depending on factors such as pressure drop and pore size). While this can be mitigated with treatment of the reject water, doing so can increase the concentration of contaminants in the waste stream.

Another significant issue with reverse osmosis is membrane fouling and scaling. Hardness components such as calcium and magnesium can precipitate scales and silica which will decrease membrane efficiency. Colloids and bacteria can also foul the membranes. Both fouling and scaling will increase the pressure drop, decreasing membrane life and increasing energy costs. Some type of pre-treatment is generally required to obtain acceptable membrane run times. Pre-treatment depends on the membrane fouling species present, but cartridge filters with or without oxidant addition are popular methods.

Some types of membranes can also be damaged by chlorine. If the membrane type is sensitive to chlorine, chlorination should either be delayed until after the unit or the water should be quenched using de-chlorination chemicals.

Other Considerations

Because reverse osmosis removes contaminants so effectively, it can significantly lower the alkalinity of the product water. This can cause decreased pH and increased corrosivity of the product water. The product water may need to have corrosion inhibitors added or to have the pH and alkalinity adjusted upwards by the addition of alkalinity. These actions may avoid simultaneous compliance issues in the distribution system such as elevated levels of lead and copper.

Reverse osmosis does not remove gaseous contaminants such as carbon dioxide and radon.

Disposal Considerations

Treatment residuals generated by reverse osmosis may include liquid concentrate and spent/used membranes. Liquid disposal options may include direct discharge, discharge to a sewer system, discharge to a wastewater treatment plant, and disposal to an underground injection control (UIC) well. Spent/used membranes will need to be disposed of in an appropriate class of landfill. The concentration of radionuclides in the liquid residual may impact disposal options due to the very high level of concentrated contaminants (including radionuclides) removed from the water. This concentration will depend on the efficiency of the reverse osmosis unit. Refer to the disposal section of the Web site for more detailed information. Disposal Issues.

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