Nitrate-nitrogen removal with small-scale reverse osmosis, electrodialysis and ion-exchange units in rural areas

JJ Schoeman*

University of Pretoria, Department of Chemical Engineering, Water Utilisation Division, Pretoria 0002, South Africa

Abstract

The nitrate-nitrogen concentration in water supplied to clinics in Limpopo Province is too high to be fit for human consumption (35 to 75 mg/ℓ NO_3-N). Therefore, small-scale technologies (reverse osmosis, ion-exchange and electrodialysis) were evaluated for nitrate-nitrogen removal to make the water potable (< 10 mg/ℓ NO_3-N). It was found that the reverse osmosis process should function well for nitrate-nitrogen removal. Nitrate-nitrogen could be reduced from a concentration of 35 to 43 mg/ℓ in 1 case to a concentration of between 1.4 and 5.5 mg/ℓ in the treated water. In another case it could be reduced from 54 to 72 mg/ℓ to 12 to 17 mg/ℓ in the treated water. The water was also effectively desalinated. The ion-exchange process could also reduce the nitrate-nitrogen concentration to less than 10 mg/ℓ in the treated water. However, the water could not be efficiently desalinated and the process should function better when the level of total dissolved solids in the feed is not very high. The electrodialysis process should also function well for nitrate-nitrogen and salinity removal. However, the electrodialysis process is more complicated to operate. The reverse osmosis and ion-exchange processes are therefore suggested for nitrate-nitrogen removal at clinics. Capital costs for small-scale reverse osmosis and ion-exchange units are estimated at ZAR7 000 and ZAR10 000, respectively. Operational costs for reverse osmosis and ion-exchange are estimated at ZAR3.16/m^3 and ZAR3.60/m^3 of treated water, respectively.

Keywords:Water quality, nitrate-nitrogen removal, reverse osmosis, ion-exchange, electrodialysis, costs