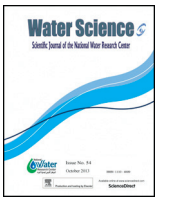
National Water Research Center
المركز القومي لبحوث المياه

Water Science

ScienceDirect

Water Science xxx (2017) xxx–xxx

journal homepage: www.elsevier.com/locate/wsj



Research Article

Reverse osmosis purification: A case study of the Niger Delta region

Iikpoemugh Elo Imiete *, Nadezda Viacheslovovna Alekseeva

Department of Technological Processes and Apparatus, Tambov State Technical University, Tambov, Russia

Received 24 December 2016; received in revised form 22 October 2017; accepted 2 April 2018

Abstract

The Niger Delta region of Nigeria is faced with the problem of drinking water supply. Different methods of water purification were compared and reverse osmosis was considered a choice method for the experiment. Among the region's brackish water reserves with heavy metal contamination, nickel and cobalt were considered. Model solutions of nickel and cobalt were prepared to mimic the brackish water contamination levels and were purified with cellulose acetate reverse osmosis membrane. Experimental results showed that purifications were more dependent on the overall salt concentrations and not on individual components.

Keywords: Niger Delta region; Purification; Reverse osmosis; Water supply

1. Introduction

The Niger Delta region of Nigeria is facing a challenge of portable water supply. The region is bounded by the Atlantic Ocean to the south and has a huge network of water sources and vast reserves of oil and gas. In 2006, the population of the entire region was 31,277,901 people (National Population Commission, 2010). A large part of this population is widely distributed along coastal communities and disconnected locations with challenging terrain to build water supply infrastructures.

Drilling of boreholes and traditional dug wells to access underground water is meeting a new phase of challenge. Some areas are experiencing an increase in the salt content of their drilled water. This could be attributed to the nature of water aquifers and the rate of exploitation, which results to a reduction in thickness and the effective head of the freshwater wedge leading to salt water intrusion into fresh water aquifers (Nwankwoala and Ngah, 2014).

* Corresponding author.
E-mail address: i.imieteelo@campus.unimib.it (I.E. Imiete).
Peer review under responsibility of National Water Research Center.

ELSEVIER Production and hosting by Elsevier

https://doi.org/10.1016/j.wsj.2018.04.001

Please cite this article in press as: Imiete, I.E., Viacheslovovna Alekseeva, N., Reverse osmosis purification: A case study of the Niger Delta region. Water Sci. (2017), https://dx.doi.org/10.1016/j.wsj.2018.04.001

Table 1a
Concentration of selected heavy metals in water from petroleum imparted river (Warri River) in the Niger Delta region during the dry and rainy season, and corresponding Nigerian standard for drinking water (Nigeria Industrial Standard, 2010).

Parameters (mg/l)	Mean values in dry season			Mean values in rainy season			NIS maximum permitted
	Point 1	Point 2	Point 3	Point 1	Point 2	Point 3	
Fe	1.28	1.56	1.47	1.41	1.36	1.37	0.3
Cr	0.57	0.44	0.33	0.45	0.34	0.33	0.05
Ni	0.48	0.49	0.68	0.38	0.47	0.54	0.02
Pd	0.99	0.72	0.82	0.95	0.92	0.78	0.01
Cu	0.55	0.30	0.37	0.42	0.30	0.28	1
Cd	0.50	0.49	0.52	0.30	0.39	0.22	0.002
Co	0.13	0.12	0.14	0.11	0.13	0.12	Nil
Hg	0.12	0.12	0.13	0.10	0.12	0.11	0.001

Table 1b
Concentration of selected heavy metals from non-petroleum imparted river (Ikpoba River) in the Niger Delta region during the dry and rainy seasons, and corresponding Nigerian standard for drinking water (Nigeria Industrial Standard, 2010).

Parameters (mg/l)	Mean values in dry season			Mean values in rainy season			NIS maximum permitted
	Point 1	Point 2	Point 3	Point 1	Point 2	Point 3	
Fe	0.22	0.16	0.27	0.12	0.12	0.11	0.3
Cr	0.17	0.15	0.16	0.11	0.13	0.11	0.05
Ni	0.08	0.06	0.04	0.06	0.04	0.02	0.02
Pd	0.20	0.17	0.18	0.10	0.17	0.18	0.01
Cu	0.11	0.10	0.07	0.01	0.01	0.02	1
Cd	0.05	0.04	0.02	0.04	0.02	0.01	0.002
Co	0.03	0.02	0.04	0.02	0.01	0.02	Nil
Hg	0.02	0.02	0.02	0.01	0.01	0.03	0.001

Besides the intrusion of salt water, the indiscriminate discharge of refuse, untreated industrial waste and the proximity of sceptic tanks to drinking water sources are some of the problems faced by the region. It is assumed that all the water sources in the region are contaminated or have the tendency of being contaminated in the future.

Analysis of 140 groundwater samples in different locations from January 2009 to November 2011 conducted by Amadi et al. (2004) confirmed that several samples did not meet the national drinking water standard. Results showed that several samples were contaminated biologically and with heavy metals. Analysis of heavy metal content in a petroleum imparted and non-petroleum imparted river in the region (Owamah, 2013), as shown in Tables 1a and 1b, attests to the prevalence of heavy metals exceeding required concentrations.

Availability of data from other researched works also corroborate Tables 1a and 1b on the level of water contamination in the Niger Delta region (Emuedo et al. 2014; Etim et al. 2013; Tubonimi et al. 2010).

2. Sources of water pollution

The dominant industry in the Niger Delta region is the petroleum industry. The country's crude oil contains heavy metals and contamination of water sources with hydrocarbons and heavy metals in part is associated with this industry.

There have been hypothesis on the geological formations that leads to the prevalence of heavy metals. Metals such as nickel and vanadium have been associated with crude oil formation from derivatives of algae and bacteria (Barwise, 1990). Other heavy metal could be as a result of geological activities and mineral accumulation during rock formation and chemical compounds used in drilling crude oil.

Drilling fluid is mainly formulated with heavy metals and corrosion inhibitors. Despite assurances of compliance with regulated requirements, both the handling of these fluids and disposals barely meet the regulatory requirements. The contributions of drilling fluid on the contamination of oil and water sources could be considered remarkable. This is coupled with the frequently recorded accidents and oil spills associated with the oil industry in Nigeria.

Please cite this article in press as: Imiete, I.E., Viacheslovovna Alekseeva, N., Reverse osmosis purification: A case study of the Niger Delta region. Water Sci. (2017), https://dx.doi.org/10.1016/j.wsj.2018.04.001