

Removal of Heavy Metal and Nitrate Nitrogen in Polluted Groundwater by Electrodialysis Process

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Abstract-High concentrations of heavy metal and nitrate nitrogen concentrations cause severe problems in groundwater system all over the world. Especially, arsenic, lead and manganese are the most common heavy metals troubled in groundwater in Korea (Kim et al., 2015). Membrane separation technologies such as electrodialysis (ED) are increasingly being utilized due to its superior removal of dissolved contaminants (Jung et al., 2011; Mendoza et al., 2015; Ortiz et al., 2006). In this study, removal of heavy metals and nitrate nitrogen by an ED system was evaluated with the polluted groundwater in a rural area. Effects of different valence on separation during ED are also discussed.

Keywords- Electrodialysis; Ion Exchange Membrane; Heavy Metal; Nitrate Nitrogen; Groundwater

MATERIALS AND METHODS

ED system was installed with five pairs of anion (AMX-SB) and cation exchange membrane (CMX-SB), purchased from ASTOM Corporation (Neosepa, Tokyo, Japan). Total available membrane area of each exchange membrane was 275cm². The voltage was maintained constant at 12V. Feed water was synthesized in the laboratory to simulate a typical polluted groundwater in Korea. Na₂HAsO₄·7H₂O (Sigma-Aldrich, Germany), Pb(NO₃)₂ (Sigma-Aldrich, Germany), MnSO₄ (Sigma-Aldrich, Germany) and NaNO₃ (Showa, Japan) was used to make stock solution. The stock solution was diluted in tap water to be 520 mg/L of NaCl, 0.1 mg/L of arsenic, 0.5 mg/L of manganese, 0.05 mg/L of lead and 30 mg/L of nitrate nitrogen concentration, respectively. ED was stopped at 100, 50 and 20 µs/cm of diluate conductivity measured continuously using a conductivity & pH meter (Thermo, Orion 5 Star).

RESULTS AND DISCUSSION

The feed water quality was 1,250~1,270 µs/cm of conductivity and 7.13~7.23 of pH. The removal of arsenic, lead, manganese and nitrate nitrogen was 73.9, 89.9, 98.8 and 95.1 %, respectively when the diluate conductivity reached at 100 µs/cm. The operation was run for 11 minutes and the maximum current was about 0.5 mA/cm². The removal showed that greater separation of nitrate than arsenic and the greater separation of manganese than lead.

CONCLUSIONS

In the polluted groundwater, various anions and cations competed to move through the ion exchange membrane under the electrical force. The behaviors of the ions with different valence will help to understand the removal efficiencies of the ED.

ACKNOWLEDGEMENTS

This work was supported by the Korea Ministry of the Environment as 'The GAIA project'.

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