2014

Application Of Data Mining For Reverse Osmosis Process In Seawater Desalination

Jaewuk Koo

Yonghyun Shin

Sangho Lee

Juneseok Choi

11th International Conference on Hydroinformatics
HIC 2014, New York City, USA

APPLICATION OF DATA MINING FOR REVERSE OSMOSIS PROCESS IN SEAWATER DESALINATION

JAEWUK, KOO[1], YONGHYUN, SHIN[1], SANGHO LEE[1], JUNESEOK CHOI[2]
(1): School of Civil and Environmental Engineering, Kookmin University, College of Engineering, 77 Jeongneung-ro, Seongbuk-gu, Seoul, 136-702, Republic of Korea
(2): Korea Institute of Construction Technology, Goyang-si, Gyeonggi-do, Republic of Korea

A data mining and data-driven modeling approaches were applied to support the operation of reverse osmosis (RO) desalination plant.

.

INTRODUCTION

Reverse osmosis (RO) processes have been widely used for seawater desalination [1, 2] due to its many advantages over evaporation processes, including low energy requirements, small footprint, modular design, and low water production costs. However, the loss of permeability caused by membrane fouling is still a serious problem in designing and operating RO processes, leading to difficulties in operation of RO desalination plant. Many theoretical techniques have been attempted to analyze RO fouling and found to be successful to investigate fouling mechanisms in laboratory-scale RO systems [3-5]. Nevertheless, they seem to be less useful to predict RO performance in pilot- and full-scale plants. Unlike fouling phenomena in bench-scale RO systems, RO fouling and deterioration in large-scale plants are complicated and hard to be understood based on mechanistic models.

In this study, this research was intended to apply techniques based on data mining and data-driven modeling approaches for the analysis of the performance of RO processes in pilot-scale systems. A genetic programming (GP) technique was applied to correlate key operating parameters and RO permeability statistically. The GP model was trained using a set of experimental data from a RO pilot plant with a capacity of 1,000 m3/day and then used to predict its performance.

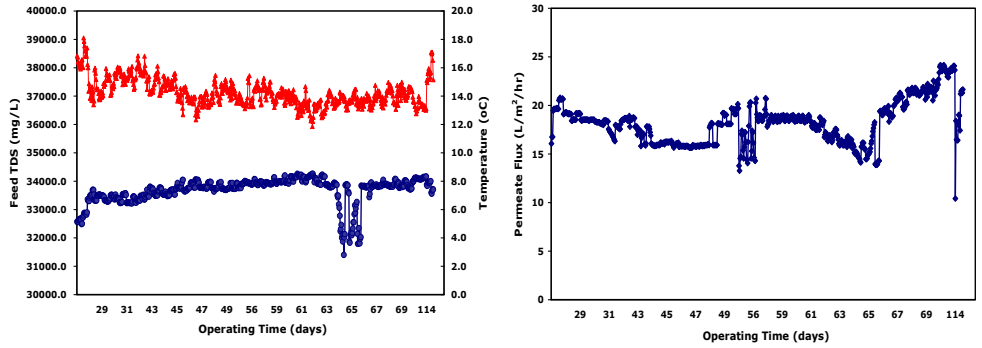
MODELING APPROACH

To obtain meaningful information from operation data of a desalination plant, a data mining technique was applied. Classification and regression were attempted to map a data item to a real-valued prediction variable, given a learned function. A data-driven modeling was also attempted based on genetic programming (GP), which is an evolutionary algorithm-based methodology inspired by biological evolution to find computer programs that perform a user-

defined task [6]. Using GP, a model to predict the complicated phenomena can be developed if experimental data is enough to evolve (or train) it.

RESULTS AND DISCUSSION

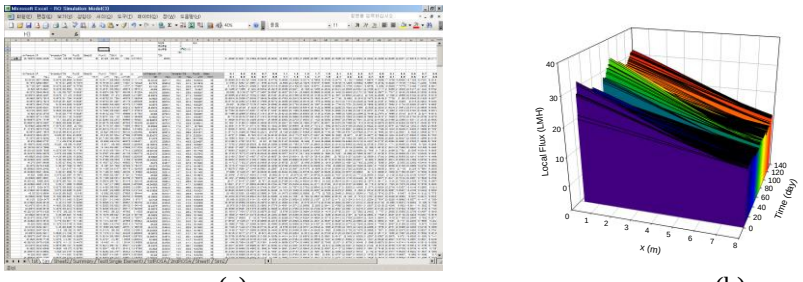
The operation data for a RO desalination pilot plant was obtained for data mining analysis. Transmembrane pressure, which is proportional to the energy consumption of a plant under a constant flux condition, was monitored as a function of time. Other parameters such as water temperature, conductivity, ORP, pH, and flow rates were recorded at the same time. Figure 1 shows an example of such data set.



(a) (b)

Figure 1. An example of plant operation data (a) water quality (b) transmembrane pressure.

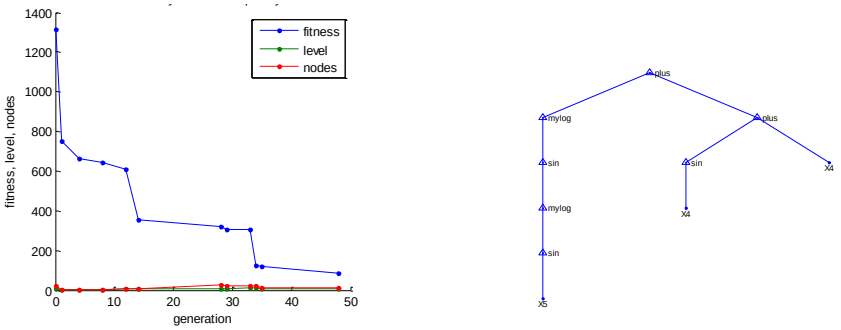
As shown in Figure 2, the data mining analysis made the in-depth information on RO plant operation available.



(a) (b)

Figure 2. (a) An MS-Excel based data mining technique (b) the information inside RO element.

GP model was also applied to match the complicated pilot plant data as shown in Figure 3 and 4. The GP models showed closed fits to the pilot plant data, implying that the GP model is more useful for the prediction and analysis of pilot or full plant operation data.



(a) (b)

Figure 3. (a) Variations of fitness, level, and notes at different generations (b) Structures of GP models

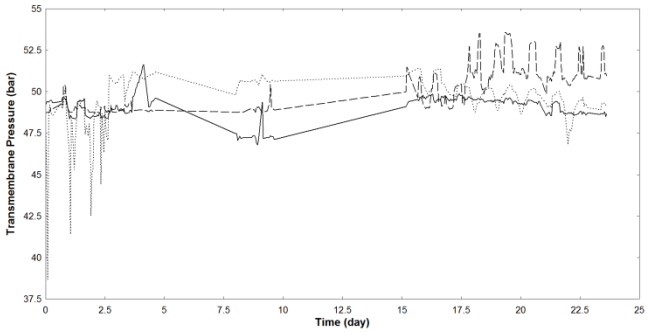


Figure 4. Comparison of GP model fits with pilot plant data

ACKNOWLEDGMENT

This research was supported by a grant (12-TI-C01) from Advanced Water Management Research Program funded by Ministry of Land, Infrastructure and Transport of Korean government.

CONCLUSIONS

In this study, In this work, approaches based on data mining were applied to analyze the operation data of a pilot plant for seawater desalination. It was demonstrated that the models were useful to understand the behavior of pilot-scale systems.

REFERENCES

[1] Hyung, H. and J.H. Kim, *A mechanistic study on boron rejection by sea water reverse osmosis membranes.* Journal of Membrane Science, Vol.286 No.1-2, (2006), p.269-278.

[2] Atkinson, S., *Japan's largest sea-water desalination plant uses Nitto Denko membranes.* Membrane Technology, Vol.2005 No.4, (2005), p.10-11.

[3] Oh, H.-J., T.-M. Hwang, and S. Lee, *A simplified simulation model of RO systems for seawater desalination.* Desalination, Vol.238 No.1-3, (2009), p.128-139.

[4] Verhuelsdonk, M., et al., *Design and optimization of seawater reverse osmosis desalination plants using special simulation software.* Desalination, Vol.250 No.2, (2010), p.729-733.

[5] Slater, C.S. and C.A.B. III, *Development of a simulation model predicting performance of reverse osmosis batch systems.* Sep. Sci. Tech., Vol.27 No.11, (1992), p.1992.
[6] Lee, T.-M., et al., *Prediction of membrane fouling in the pilot-scale microfiltration system using genetic programming.* Desalination, Vol.247, (2009), p. 285–294.