Chapter 19
Artificial Neural Network Modelling of Sequencing Batch Reactor Performance

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ABSTRACT

Sequencing batch reactor (SBR) is a versatile, eco-friendly, and cost-saving process for the biological treatment of nutrient-rich wastewater, at varying loading rates. The performance of a laboratory-scale SBR was monitored to ascertain the chemical oxygen demand (COD) and total nitrogen (T-N) removals under four different operating conditions, by varying the operating time for the nitrification/denitrification steps, i.e., the cycle times. A multi-layered neural network was developed using COD, T-N, carbon to nitrogen ratio (C/N), aeration time, and mixed liquor suspended solids concentration (MLSS) data. This chapter compares the neural simulation results to the experimental results and extracts information on the significant factors affecting SBR performance. The application of artificial neural networks to biological processes such as SBR is a relatively new technique in wastewater and water quality management, and the results presented herein indicate the promising start of the adoption of computational science in this domain of research.

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INTRODUCTION

Background Information on Saline Wastewater

Water quality is continuously degrading as a result of the free flow of contaminants like suspended solids, organic wastes, bacteria, nitrates, phosphates and other recalcitrant chemicals. Considering a general case, as point source pollution, excessive amount of nitrates bearing wastewater are generated from pulp and paper, ammunition manufacturing facilities, besides being generated enormously as non-point source run-offs from the over application of nitrogen rich fertilizers (Metcalf and Eddy, 2003). When ingested, nitrate is converted to nitrite, which then reacts with haemoglobin in blood to form methemoglobin, a condition that severely affects the oxygen transport mechanism in blood.

Physical, chemical, and biological treatment systems have been successfully implemented in industrial facilities for environmental management, as an end-of-pipe treatment step, *i.e.,* before ultimate discharge. The implementation and use of biological techniques, *viz., aerobic and anaerobic*, for treating toxic chemicals present in wastewater is exponentially growing at the industrial level, especially considering the degree of treatment accomplished at a low cost. Though biological systems have been used efficiently for handling high-strength wastewaters, there is very little information available about their effectiveness for handling saline wastewaters, especially those arising from fish cleaning industries (Soto et al., 2002; Chowdhury et al., 2010).

This study aims to address this issue, by proposing a sequencing batch reactor as the biological treatment step for the treatment of liquid waste generated from a fish market zone near the harbour in Ulsan city, South Korea. The saline rich wastewater generates mainly from fish cleaning, floor washing, raw material washing and from melted ice packs. Additionally, the characteristics of wastewater also depend on the seasons and the different varieties of fish caught over a particular period. This wastewater is likely to contain low levels of soluble protein, fish scales and high salt content. Generally, the most commonly used approach to discard this type of wastewater is to mix it with the municipal sewerage system, before treatment in a centralized wastewater treatment plant. However, discharging these wastes is not a simple task, as the magnitude depends principally on the waste volume, rate of discharge and the assimilatory capacity of the receiving medium. High salt content may pose severe adverse effects during combined treatment of these liquid wastes. High salt content (>1%) could cause plasmolysis and loss of activity of the biological cells and affects system performance (Uygur and Kargi, 2004). The various physical and chemical parameters such as solid content, pH, temperature, odor, organic matter such as biochemical oxygen demand, chemical oxygen demand, oil and grease content, nitrogen and phosphorous content should be evaluated before choosing an appropriate treatment system.

This chapter provides the reader an useful insight into the process fundamentals of sequencing batch reactor operation, and links the application of artificial intelligence, *i.e.,* artificial neural networks, to model biological wastewater treatment process. It provides a description of neural networks, the importance of network parameters for neural modeling and sensitivity analysis. Anew, an explanation of the methodology adopted to collect the experimental data from the sequencing batch reactor, data analysis, and neural modeling results are also discussed from a practical view-point.

SEQUENCING BATCH REACTOR OPERATION

A sequencing batch reactor can be used to attain high treatment efficiencies, as secondary treatment systems, for simultaneous nitrification and denitrification in one reactor configuration, operated