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Modeling and Optimization of Reverse Osmosis Plant for High Salinity Water from Shatt Al-Arab River in Southern Iraq

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Abstract

High salinity in the Shatt al-Arab River is becoming a serious issue for scientists and experts in the Basra Governorate, Iraq, and the local authorities are searching for solutions. This study aims to model and simulate the performance of the GARO2 desalination plant in the Garmatt-Ali region using Winflows 4.04 program. The high salinity of the Shatt al-Arab River elevated the salinity level of the water. The software was used to simulate the long-term operation of the GARO2 desalination plant. The results show a good agreement between the practical aspect and the modeling process, with the highest deviation being up to ± 10%. Furthermore, Genetic Programming and Genetic Algorithms were employed to develop and analyze the objective functions were associated with the most effective factors, such as the permeate flow rate, water flux, permeate water concentration, and salt rejection. The Genetic Algorithm was used to determine the optimal values of independent variables for each objective function. The findings of this study provide valuable insights into the design and optimization of reverse osmosis desalination units used to treat brackish water from the Shatt al-Arab River in Southern Iraq, thereby enabling the development of more efficient water management options in the region.

Keywords: Desalination; Genetic Algorithm; Optimum condition; Simulation model

1. Introduction

The construction of numerous dams on the Tigris and Euphrates Rivers, mainly in Turkey, combined with unregulated water consumption in Iraq, has led to water scarcity. The salt concentration in the Shatt al-Arab River has increased significantly owing to the mixing of saline and fresh water. To address the population's need for household water (for activities such as washing, drinking, and rinsing), there is an immediate need to identify a viable substitute that offers long-term availability of safe drinking water. Of all the available alternatives, the reverse osmosis (RO) units are the most significant. However, this option is limited due to lack of research and practical knowledge regarding the elevated salt levels in the Shatt al-Arab.

Notably, the lack of research on the simulation and optimization of desalination plants in the study area motivated our research team to further explore this field, particularly due to the presence of multiple governmental and private desalination plants in the region.

Yousif *et al.* (2022) conducted a study to analyze and simulate a desalination plant in the Al Maqal Port. After conducting field and laboratory tests of permeate water samples, they found that the water was suitable for human use and met the Iraqi Standard Specifications (IRS). By calculating the R2 factor using Winflows 4.04 program, the simulation process was determined to closely match the practical results with an error rate of 17%. While the recovery rate fell within