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Review of seawater natural organic matter fouling and reverse osmosis transport modeling for seawater reverse osmosis desalination

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ABSTRACT

To date, over 80 papers on transport modeling and natural organic matter (NOM) relating to seawater reverse osmosis (SWRO), have been reviewed. As a result of such focus, NOM, one of the main foulants related to reverse osmosis (RO) membranes, has been shown to possess intrinsic chemical complexities and ambiguities, necessitating further investigation. Consequently, since such NOM fouling and transport mechanisms associated with SWRO are not fully understood, a summation of previous studies has been included in the paper in question to systematize information, not only as to RO membrane transport modeling, but NOM fouling characteristics, as well. Accordingly, RO transport models in the review are classified into three categories: diffusion-based, pore, and irreversible thermodynamic models. In addition, specific features, unique assumptions, and applications for each model are examined. The paper consists of the following components towards meaningful understanding of NOM fouling model development during SWRO: 1) SWRO fundamentals as to membranes, 2) NOM fundamentals as to seawater, 3) RO transport modeling theories, 4) conclusion, and 5) future directions of NOM fouling model development.

Keywords: Natural organic matter (NOM); Seawater reverse osmosis (SWRO); Membrane transport models; Fouling mechanism

1. Introduction

Desalination processes have emerged as an effective solution for solving potable water shortages, quickly emerging as a major global problem [1,2]. Especially, seawater reverse osmosis (SWRO) membrane desalination, in relation to thermal desalination, e.g., multistage flash desalination (MSF) and multi-effect distillation (MED), is more technologically feasible in reducing energy consumption during fresh water conversion [3]. Apart from such merits, membrane fouling during SWRO application persists as a major impediment, reducing operation efficiency during filtration process.

Reverse osmosis (RO) membrane fouling is classified according to the following foulant types: particle/colloidal, biological, inorganic (scaling), and organic fouling [4]. Particularly, natural organic matter (NOM) fouling has emerged as a focal point in research and application, playing a key role in irreversible fouling generation during SWRO desalination. Contrary to reversible fouling, easily cleaned by back washing, irreversible fouling requires chemical cleaning due to permanent bonding of organic matter and other foulants (e.g., inorganic matter and colloids) [4,5]. However, fundamental NOM fouling mecha-

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