Desalination and Water Treatment
www.deswater.com

doi: 10.5004/dwt.2021.26825

217 (2021) 31–41
March

Dynamic modeling and simulation of the multi-effect distillation desalination process

Jianqing Hu[a], Lianying Wu[a,*], Yan Wang[b], Weitao Zhang[a], Yangdong Hu[a]

[a]*College of Chemistry and Chemical Engineering, Ocean University of China, Qingdao, Shandong, China, 266100, Tel. +8613791914873; emails: wulianying@ouc.edu.cn (L.Y. Wu), hujianqing.cool@163.com (J.Q. Hu), 55768616@qq.com (W.T. Zhang), ydhuhd@ouc.edu.cn (Y.D. Hu)*
[b]*College of Chemistry and Chemical Engineering, Qingdao University, Qingdao, Shandong, China, 266071, email: yanwang@qdu.edu.cn*

Received 22 May 2020; Accepted 20 November 2020

ABSTRACT

Accurate description and analysis of the dynamic behavior of state variables in multi-effect distillation (MED) desalination process is a challenge for its characteristic of numerous variables and their complex correlation. This paper is aimed at exploring the dynamic response of state variables with the derived dynamic model in MED desalination process, including evaporate temperature, salinity, evaporation mass flow rate and brine pool level. Adopting the reported modeling strategy, a rigorous dynamic model of the MED is established by coupling the dynamic equations of mass, salt and energy balance of the system, considering the relation between the state variables and the operating time. The dynamic model is solved in finite time and the influence on state variables is investigated under specific conditions, that is, by importing disturbance in feed temperature, feed flow and/or steam flow. From the point view of process control, the indices of maximum deviation (MD), response time (RT) and transition time (TT) are applied to analyze the transition process of state variables, serious parameters of which are significant for PID controller and control scheme deployment, especially in multistage and integrated process. The parameters of a designed nine effects advection MED plant in China are taken as the initial input data of the model in simulation and analysis part. Simulation results demonstrate the transition process and the approximate data of MD/RT/TT for the state variables in the case plant. The evaluation process might promote the practical application of dynamic simulation result for control scheme implement and the further control strategy research.

Keywords: Seawater desalination; Process modeling; Multi-effect distillation; Dynamic simulation

* Corresponding author.

1944-3994/1944-3986 © 2021 Desalination Publications. All rights reserved.