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A New Approach for Determination of Neck-Pore Size Distribution of Porous Membranes via Bubble Point Data

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ABSTRACT

Reliable estimation of the porous membranes neck-pore size distribution (NPSD) is the key element in the design and operation of all membrane separation processes. In this paper, a new approach is presented for reliable determination of NPSD of porous membranes using wet flow-state bubble point test data. For this purpose, a robust method based on the linear regularization theory is developed to extract NPSD of membranes from bubble point test data. The performance of the proposed method is tested using various experimental data. The predicted results clearly demonstrate that the proposed method can successfully predict the proper NPSD from a set of bubble point test data.

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1. INTRODUCTION

Porous ceramic, metal and polymer films are widely used as filter or membrane in various separation processes. They are used in different applications such as materials supporting, noise suppressor, biomedical implants, gas dispersers, distillation and centrifugation. The membrane technology is also having wide applications in water and wastewater industry, food industry, pharmaceutical and medical industry, biotechnology, air filtration and gas purification. Characterization of membranes structure in terms of pore size distribution (PSD) is an important step in research and development of porous materials [1-3]. The PSD is a useful parameter for optimization of different membrane processes and commercial manufacturing of the membranes. Various methods have been proposed for characterization of PSD of porous membranes. The major ones are presented below: Bubble pressure breakthrough method is based on the measurement of the pressure necessary to blow air through a porous membrane filled with liquid [4-6]. Mercury porosimetry is based on the same principles as the bubble pressure method; but now a non-wetting (mercury) is used to fill a dry membrane [7, 8]. Electron microscopy which is available to view the top or cross sections of membranes, such as scanning electron microscopy (SEM) [9], transmission electron microscopy (TEM) [10] etc... Atomic force microscopy used to study of non-conducting materials surface (down to the scale of nanometers) [11, 12]. Solute retention challenge, in which pore sizes can be evaluated by measurement of rejection for various solutes of increasing molecular weights or hydrodynamic sizes [13]. Adsorption–desorption methods, in which pore size distribution can be also analized by gas adsorption/desorption devices (BET adsorption theory is one of these methods) [14]. Thermoporometry is based on the fact that the solidification point of the vapour condensed in the pores is a function of the interface curvature [15, 16]. Permporometry is based on the controlled blocking of pores by condensation of vapour and measurement of the gas flux through the membrane [17, 18]. NMR measurements method is determination of pore size in water-saturated membranes using nuclear magnetic resonance (NMR) [19, 20].

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