What is the concentration threshold of nanoparticles ~~into~~ within the membrane structure? A case study of Al_2O_3/PSf nanocomposite membrane

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Abstract

In this study the effects of Al_2O_3 nanoparticles concentration were investigated on the membrane structure/performance ~~were determined,~~; the boundary of variations was detected,~~;~~ introduced as Nanoparticle Concentration Threshold (NCTh)~~;~~, and ~~–~~was used for forecasting the field of membrane application. For this purpose, Al_2O_3 nanoparticles with a size of 70 nm and a concentration between 0 to 0.52 wt.% were added to the membrane matrix. Loading threshold of Al_2O_3 nanoparticles were evaluated and the properties of the nanocomposite membrane were compared ~~up~~ above and ~~sub~~ below the loading threshold ~~were compared~~. Rheometric analysis, contact angle measurement, SEM images, and filtration experiments showed that concentration threshold of Al_2O_3 nanoparticles was 0.39 wt.%. Based on their properties, the antifouling performance of those membranes possessing Al_2O_3 concentration below the threshold was evaluated in a membrane bioreactor (MBR).

Key words: nanocomposite membrane; Al_2O_3 nanoparticles; concentration threshold.

1. Introduction

Nanocomposite membranes have attracted a growing research interest in recent years, [1-3] because they elevate membrane hydrophilicity ~~with the help of~~by means of hydrophilic nanoparticles, ~~which is~~ considered as a good remedy for increasing the membrane resistance against fouling [4-8]. Metal oxide nanoparticles, as materials with extraordinary hydrophilicity, have received great attention in recent years [9- 11]. The membrane structures ~~resulting~~ obtained from the presence of nanoparticles in a polymeric matrix can be used as a multi-functional tool on the account of possessing the simultaneous specific properties of the nanoparticles and the polymer matrix [9]. Based on the conducted studies, the presence of nanoparticles generally leads to hydrophilicity development and fouling reduction of polymeric membranes in filtration operations [9-11]. In addition, the presence of TiO_2, ZnO, Al_2O_3, ZrO_2, SiO_2, Fe_3O_4, Ag and Fe, results in an increase in mechanical and thermal resistance of polymeric membranes [9-13]. ZnO [14], TiO_2 [15-25], and Ag [26-29] have anti–bacterial properties, ZrO_2 [30, 31] and Fe [32- 34] have catalytic and mechanical properties, SiO_2 possesses conductive features [34-38], and Fe_3O_4 nanoparticle donates magnetic properties to a polymeric membrane [39, 40, 41].

Expect to??? nanoparticle type, the effect of nanoparticles on the structure and filtration performance of nanocomposite membranes depends on the size [17], how they ~~were~~ are added to the polymeric matrix [19, 41] and amount of nanoparticles [9, 12, 25, 43, 44]. ~~In term of~~Regarding the nanoparticles loading concentration, different researchers have blended nanoparticles into the membrane matrix and reported the best concentration without giving any hint ~~to~~ about the boundary and reason behind the variations [14-41].