Abstract

Ultrafiltration is a widely-used membrane process for water purification. While the application of the process is an established practice, there is still a profound interest in the improvement of the membranes. The present work is about the preparation of polyvinylidene fluoride (PVDF) membranes and nanocomposite membranes with zinc oxide nanoparticles. As a first step, a basis membrane was developed which exhibited an attractive filtration performance. This membrane formulation was optimized and produced in pilot scale. Meanwhile, nanocomposite membranes were prepared using the formulation of the basis membrane as starting point. For the preparation of the dope solution, the nanoparticles were dispersed in the solvent and the polymer was added afterwards. The membranes were prepared by the non-solvent induced phase separation (NIPS) under controlled climate conditions. It was evaluated how several factors effect the agglomeration and integration of the particles during the phase separation. These were the implementation of the hydrophilic additive polyvinylpyrrolidone (PVP) in the dope, the rate of the phase separation, the surface modification of the particles with PVP, trifluoroacetic acid, acetic acid, and oxalic acid, and the presence of acrylic acid (AA) repetition units in the membrane polymer. It was found that the implementation of PVP and the reduction of the phase separation rate reduce the agglomeration tendency of the particles while the integration was not improved. The particle surface modification with carboxylic acids exhibited no influence on the membrane over the pristine particles. This can be attributed to the low surface coverage and the instability of the modification under the conditions of dope solution preparation. In contrast, the surface modification with PVP facilitated a change in the Hansen parameter of the particles. This led to a decrease of agglomeration even in hard non-solvents and improved the integration of the particles into the polymer matrix. The implementation of the copolymer P(VDF-*co*-AA) as membrane polymer induced a comparable effect under the condition that soft non-solvents were used. Since hard solvents disrupt the bonding between the polymer and the particle. Some results indicated that the increase in particle size, which is caused by agglomeration in the dope solution, can lead to a better integration of the particle because the decrease in diffusivity hinders the migration of the particles into the non-solvent phase.