Modification of microfiltration membranes by supercritical solvent impregnation

Marcin Tyrka, Mariusz Nowak, Anna Trusek, Irena Zizovic

Wroclaw University of Science and Technology, Faculty of Chemistry, Wybrzeze Wyspianskiego 27, 50-370 Wroclaw, Poland

The study reveals the feasibility of the supercritical solvent impregnation (SSI) in modifying commercial polymeric membranes to obtain materials with strong antibacterial properties. Such membranes might be of interest in a wide range of biomedical applications to ensure a sterile environment and prevent any attachment of bacteria to the material. The data related to polyamide (PA), cellulose acetate (CA), regenerated cellulose (RC), and poly(tetrafluoroethylene) (PTFE) membranes, and thymol and carvacrol as bioactive components are presented.

The SSI was performed in a 280 mL high-pressure vessel under the batch conditions at a temperature of 40 ^{o}C and pressure in the range from 10 MPa to 20 MPa. The process kinetics was followed. Modified membranes were characterized by scanning electron and ion-beam microscopy and FTIR methods. The membranes' performance was tested in a cross-flow filtration system. *Escherichia coli* and *Staphylococcus aureus* were used either in the filtration itself or as an incubation medium for membranes to investigate their blockage due to the fouling phenomenon.

The results revealed a fast impregnation process with high achievable loadings of active substances, up to 43%. The higher the pressure, the faster the impregnation process. The pressure of 15 MPa can be considered optimal for CA, PA, and RC membranes. In the case of PFTE, a pressure of 20 MPa is required. Maximal loadings for PA and CA were approximately 43%. For RC and PTFE these values were around 22% and 11%, respectively. The microscopy analyses and cross-flow filtration tests showed that defined polymeric structures of commercial membranes stayed preserved even with high loadings (27% for CA and 35% for PA). The impregnated membranes were prone to cell adhesion. Possible applications of the obtained porous structures loaded with antibacterials in the biomedical field and wound ventilation were commented. The advance of these materials application in wound ventilation is that they can serve as a bacterial membrane and as a source of the antiseptic substance at the same time. Preliminary results related to this application are presented.

Acknowledgments: The research was financed by the National Science Centre, Poland, in the frame of Project OPUS 16 UMO-2018/31/B/ST8/01826.