NANOFILTRATION-ASSISTED REMOVAL OF ACRIFLAVINE FROM AQUEOUS SOLUTIONS

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Abstract

Nanofiltration membranes were modified using Layer-by-Layer method. Different number of polycation/graphene oxide bilayers was deposited on the surface of the membranes. The structure of modified membranes was studied under optical microscope. The structure of graphene oxide was investigated using transmission electron microscopy and dynamic light scattering. The experimental properties of modified membranes were determined using acriflavine solution in a bench scale setup. The retention of the membranes increased with an increasing number of bilayers to a point, similar to a saturation curve. The flux of the permeate decreased slightly, converging to a lower limit with increasing number of bilayers. The results show that nanofiltration membranes can be effectively modified using polycation/colloid particle bilayers.

Introduction

The use of pharmaceuticals in the world increases year-by-year. Pharmaceutical products are released in wastewater streams from manufacturing sites. The production and use of a comprehensive portfolio of pharmaceutical products results in wastewater with a complex composition which is difficult to treat to levels in compliance with regulation from industry authorities. Reverse osmosis (RO) and nanofiltration (NF) have proved to be effective in the removal of various pharmaceuticals [1]. Three factors affect the efficiency of RO and NF in the removal of organic compounds (membrane, molecular, and background fluid characteristics) via three main mechanisms: size exclusion, adsorption, and electrostatic repulsion/attraction [2]. The use of acridines as antimicrobial agents was first proposed in 1912, and the first clinical use of these agents already occurred in 1917. Many compounds containing the acridine chromophore were synthesized and tested, and the aminoacridines bound wide use, both as antibacterial agents and as antimalarials, during World War II. The emergence of the penicillins eclipsed the acridines in antisepsis due to the greater therapeutic efficacies of the former. However, with the current massive increases in drug-resistant bacterial infection, new acridine derivatives may be of use[3]. In addition, the topical utilization of aminoacridines in conjunction with directed low-power light offers bactericidal action at much lower doses. This study focuses on the removal of acriflavine, using commecially available NF membranes, in a crossflow setup. We also modified the employed NF270 membranes with carbon nanosheets and studied their effects on the key performance parameters.

Experimental

Graphene oxide was synthesized using modified Hummers method. The resultant graphene oxide suspension was thoroughly dialyzed to remove any impurity that can modify the layer-by-layer deposition.

The membranes were modified using Layer-by-Layer method. The membrane was immersed in poly(diallyldimethylammonium chloride) solution and graphene oxide dispersion 10 minutes each per bilayer.

The membranes were tested in a crossflow experimental setup (Figure 1.) using the model molecule acriflavine. The retention was determined from the absorption of feed and permeate solutions. The flux of the permeate was measured using a measuring cylinder. The experimental setup was operated at 100 psi and 50 liter per hour crossflow. The active area of the membrane was 42 cm^2.

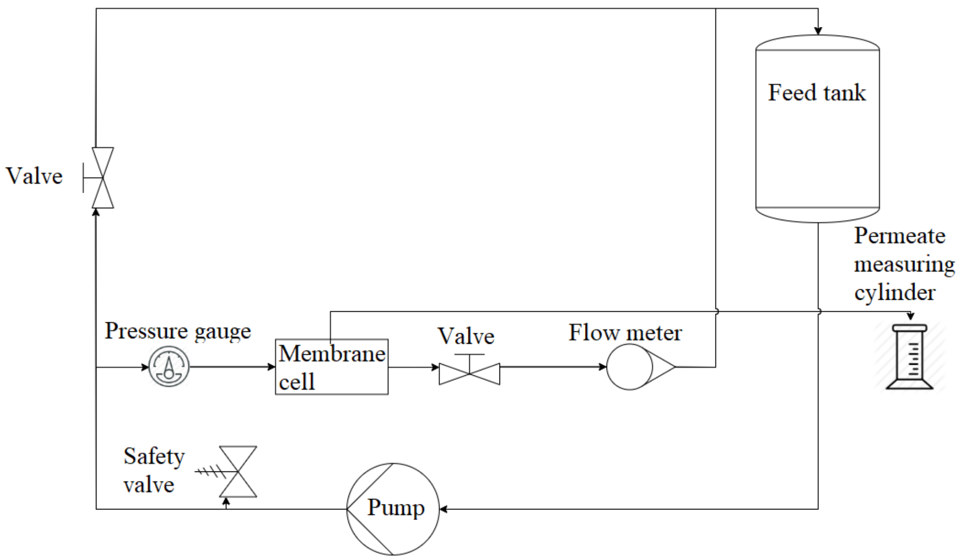

Figure 1. The scheme of the experimental setup

Results and discussion

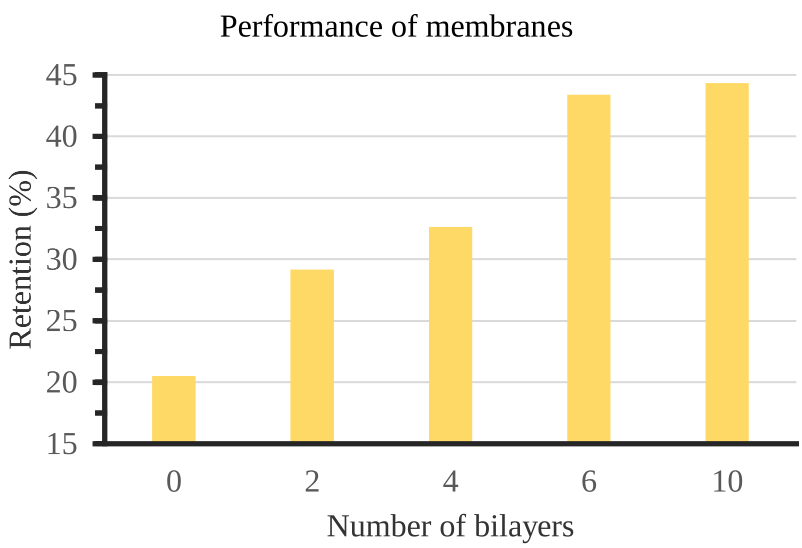

Figure 2. Effect of the number of bilayers on the acriflavine retention of membranes

As Figure 2. shows the Layer-by-Layer modification changed the retention of the membranes in a bilayer number dependent manner. The retention of membranes increases with increasing number of bilayers. After 6 bilayers the retention increase is non-significant. The retention values follow a saturation curve. This shows that the bilayer is not a standard filtration layer, because then it would show an exponential increase.

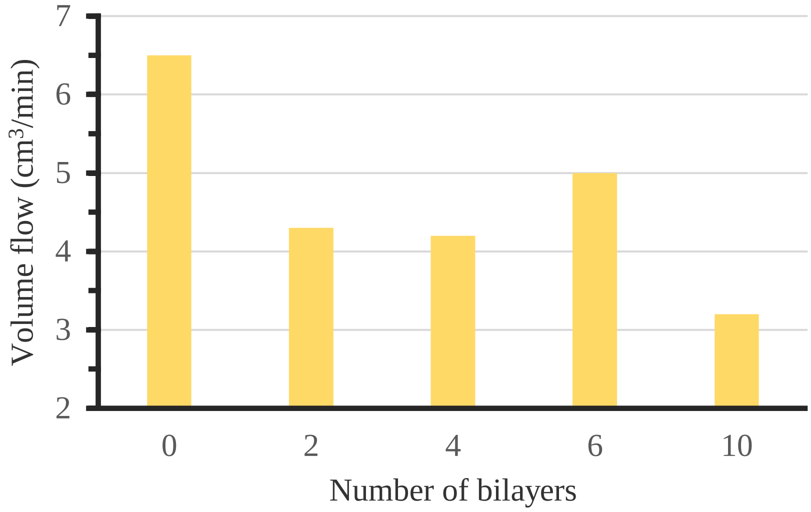

Figure 3. Effect of the number of bilayers on permeate volume flow

The Layer-by-Layer modification decreased the volume flow of the membranes as seen in Figure 3. The volume flow of the membranes decreases with increasing number of bilayers. The volume flow of membrane with 6 bilayers is probably anomalous and too high. The volume flow values converge to a lower limit. Similar to retention values this indicates that this is not a standard filtration layer, because then the trend would be an exponential decrease.

Conclusion

Poly(diallyldimethylammonium chloride)/graphene oxide bilayers increased acriflavine retention and slightly decreased the flux of the permeate. The modified membranes have improved properties for acriflavine removal. The properties of bilayers warrant further research using different polymers/nanoparticles/pH.

Acknowledgements

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