Original Research Paper

Volume - 7 | Issue - 6 | June - 2017 | ISSN - 2249-555X | IF : 4.894 | IC Value : 79.96

Science

PLASMA MODIFICATION OF POLYMER ULTRAFILTRATION MEMBRANES

Elisaveta Petrova Nedyalkova

Technical University – Sofia, College in Sliven, Bulgaria, 8800 Sliven, 59 Bourgasko Shaussee Blvd

KEYWORDS : polymer membranes, ultrafiltration, chemical treatment, plasma modification, phase inversion.

Introduction

Plasma modification is one of the most modern for modifying the surface of polymeric materials. It enables the properties of the surfaces of these materials to be wiped out in a wide range and significantly increase their use [1, 2]. Various methods of plasma processing are known which prove to be very effective in improving the properties of polymeric membranes and result in the production of new composite membranes with unique properties [3,4].Cold plasma processing is associated with the use of radio frequency or direct current smolder discharge. Plasma processing can control the size of the membrane pores and its performance by varying the operating parameters and the gas environment [5,6].

Experimental

The membranes used for the present studies were prepared under laboratory conditions by the phase inversion method, known also as the method of Loeb. [7]. The membrane (PAN I) had the following composition: PAN – 16.25 mass%, PMMA – 0.25 mass%, $CuSO_4$. $5H_2O$ – 2.5 g/l [8]. The performance characteristics of the metallized membranes - permeation flux (J) and retention (R) were determined on a laboratory apparatus "Sartorius" SM-165 (England) by the following equation:

$$J = \frac{V(t)}{Sbt}\left(m^3/m^2h\right) \; R = \frac{C_0 - C_i}{C_0}.100(\%) \qquad \text{Eq. (A.1)}$$

where V(t) denotes the volume of passed liquid (m^3); Sb – effective area of the membrane (m^2); t – time (h); C_0 - initial concentration (kg/m^3); C_i - concentration of the filtrate (kg/m^3).

Membrane selectivity was measured using the calibrant "Albumin" – human serum /M_w=67000/ (Fluka) with initial solution concentration 1 g/l. The separation ability of the membrane compared to the calibrant was determined spectrophotometrically at wave length λ=280 nm on a UV/VIS spectrophotometer "Unikam"-8625- France.

Results and Discussion

Low-temperature plasma provides great possibilities for adjusting hydrophilic-hydrophobic balance of surface charge as well as for grafting of different functional groups. [9].

The plasma is obtained at a barrier discharge of 50 Hz in air at atmospheric pressure. It can be seen from Fig. 1 that this type of modification leads to a substantial change in membrane water permeability. Regardless of the different polymeric membrane composition, suggesting a different membrane structure, hence different performance characteristics, the same tendency is observed, namely to reduce water permeability (at 5 MPa), relative to unmodified membranes at the same pressure. The explanation is the formation of different types and number of active centers and their interaction with the membrane structure.

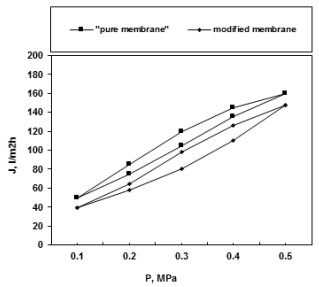

Fig.1. Water permeation flux of the membranes of pur and plazma modified (10 kV, 3 mm, 10 min, 2 x 1mA).

Plasma treatment in air leads to the etching and / or accumulation of oxygen-containing groups on the surface depending on the chemical nature of the modified polymer and the conditions of the experiment. Increasing membrane water permeability is probably due to the accumulation of oxygen-containing groups on the membrane surface.

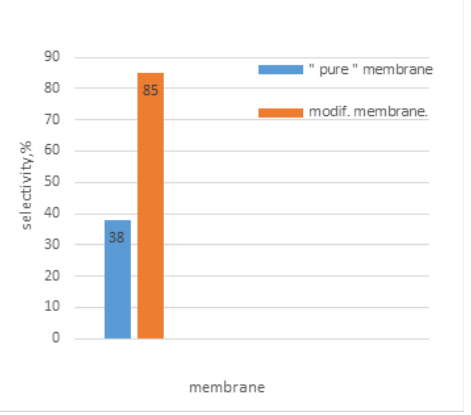

Fig.2. Selectivity towards Albumin (under 0,3 MPa) of pur and plazma modified membrane (№1-10 kV, 3 mm, 10 min).

This results in increased polarity and hydrophilicity as well as surface etching and partial destruction of the membrane selective layer. This also necessitated the study of the selective and permeable characteristics of the same membranes as compared to the calibrant Albumin at a pressure of 3 MPa. In Fig. 2 shows a tendency to decrease the membrane selectivity relative to the base membranes.

Conclusions:

The possibility of plasma modification of polymer ultrafiltration membranes with different polymer composition has been investigated and proved. Modifications have been made to modify the performance of modified membranes to make them applicable to specific optimization tasks.

References:

1. Гильман, А.Плазмохимическая модификация поверхности полимерных материалов // Школа по плазмохимии для молодых ученых Росии и стран СНГ. – Иваново, 1999, ИГХТУ, р. 348.
2. Garbassi, F., M. Morra, E. Occhiello. Polymer Surface from physics To Technology. New York: Wiley, 1994, p. 386.
3. .Kravets L., S. Dimitriev, A. Gilman. Modification of properties of polymer membranes by low – temperature plasma treatment. – High Energy Chemisrty, 43,2009, p.181-188.
4. Chan, C. M. Polymer Surface Modification and Characterization. Munich, Carl Hanser, 1993.180p.
5. Tran, T., S. Mori, M., Suzuki. Plasma modification of polyacrylonitrile ultrafiltration membrane. – Thin Solid Films, 515, 2007, 9, p. 4148-4152.
6. Славова В, Ст. Петров. Изследване промяната на характеристиките на ултрафилтрационни полимерни мембрани модифицирани чрез плазмена обработка. Известия на ТУ – Сливен, 2, 2014.
7. Loeb S., S. Sourirajan, (1962), Adv.Chem. Ser.,38,11.
8. Slavova V. St. Petrov, M. BaevaA study on the change of transport and selective properties of ultrafiltration polymer membranes after vacuum metallization with iron-chromium-nickel alloy. MODERN TECHNOLOGIES,IN THE FOOD INDUSTRY-2012, Volume II, Republic of Moldova
9. Динев, П. Електротехнология. София, ТУ, 200.421с.