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A Review on Preparation and Characterization of Hollow Fibre Ultra filtration Membrane

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Abstract – The necessity of effective filtration technique had been employed by the researchers to make alternatives which have most efficient ways. This makes us to focus on the field of PVDF hollow fibre membrane where the filtered potable water comes out as permeate. The study of hollow fibre membrane is an effective area because of its high water flux. The concept of hollow fibre membrane plays an important role in the preparation and characterization techniques. An attempt is made in this paper to review the literature related to the hollow fibre membrane and modifications made to improve the permeate level.

Keywords: hollow fibre membrane preparation, hollow fibre membrane characterization, Performance of hollow fibre membrane

I. INTRODUCTION

The hollow fibre membranes are found to have a wide range of applications ranging from the for Drinking Water Treatment Process, Dialysis and other blood treatments, Process waste water treatment and solvent-exchange of proteins (via diafiltration). These hollow fibre membranes had become the essential requirement of the current society as they do not cause any harmful effects to the environments but provides us comparatively cheaper filtration techniques currently available in market. The cost associated with this hollow fibre membrane is also very less and economical. One of the concerns regarding these hollow fibre membranes is to improve preparation techniques and their performances. The survey and researches had been carried out in a large manner to improve these preparation and characterization techniques of hollow fibre membrane. In this context, an objective is set to review the literature related to hollow fibre membranes. under the following categories: preparation of hollow fibre membrane characterization techniques involved in hollow fibre membranes and the performance associated with the hollow fibre membrane.

II. LITERATURE REVIEW

A. Preparation of hollow fibre membranes.

Naser Tavajohi Hassankiadeh (2014) analysed that to obtain a homogeneous solution, a specific amount of polymer and diluents were fed into the vessel polymer and diluents were fed into the vessel, heated up to 190 ^{o}C, and mixed for 2h. Then the homogenous polymer solution was extruded through the spinneret by a gear pump under a nitrogen pressure of 0.3MPa to a coagulation bath at 3 and 15 ^{o}C, a washing bath at 10 and 20 ^{o}C. The spinneret temperature was maintained at 190 ^{o}C in all experiments, and the diluents were introduced to the inner orifice at high temperature (190 ^{o}C) to make alumen of the hollow fibers [1].

Long Lin (2015) suggested that PVDF hollow fiber membrane was prepared through TIPS method using GTA and DBS as the mixed diluents. The PVDF powder was dried at 100 °C for 24 h and poured into a tank containing GTA and DBS solvents which was subjected to continuous stirring at 200 °C for 12 h, under the nitrogen pressure of 0.2 MPa [2].

Fu Liu (2011) had performed that phase inversion methods are mainly used because of its simplicity and flexible production scales. Phase inversion can be described as a demixing process whereby the initially homogeneous polymer solution is transformed in a controlled manner from a liquid to a solid state [3].

Qinglei Zhang (2014) had been made The PVDF hollow fiber membranes were prepared by non-solvent induced phase separation (NIPS) through spinning equipment, Casting dopes were prepared by adding PEG (6000 Da) into the solvent, including PVDF, 1,4-diethylene dioxide and *N*,*N*-dimethylacetamide (DMAC), followed by stirring at 70 °C until the solution became homogeneous. 1, 4-diethylene dioxide and kept at a constant temperature of 70 °C for 12 h to eliminate the air bubbles [4].

Ningen Hu (2016) proposed the PVDF, PVA and CPL were mixed in a container proportionately to prepare a casting solution. The solution was heated up in an oil bath under the protection of nitrogen at 140 _C and stirred at a constant speed of 120 rpm to form a homogeneous dope solution. The solutions were degassed at the preparation temperatures and then were rapidly casted on the glass plate by an automated high-temperature casting machine described elsewhere [5].

Bing Wu (2007) had done a polymer dope solution was prepared by firstly mixing a required amount of solvent DMAC and solid LiCl in a 1-L wide neck flask immersed in a water bath maintained initially at 25 ^{o}C. A predetermined amount of PVDF polymer pellets was then introduced into the solvent and stirred at a low speed of 150 rpm at 258C for half an hour to thoroughly wet the polymer pellets and prevent the formation of polymer lump [6].

Mohamed Khayet and Takeshi Matsuura (2001) made the preparation of casting solutions, water/DMAC mixtures (water content from 0 to 8 wt %) were first prepared, and then PVDF was added to the mixtures so that the PVDF concentration in the solution became 15 wt %. Thus, the water content in the casting solution changed from 0 to 6.8 wt % [7].

M. Khayet (2002) suggested that hollow fibre membrane spun at room temperature employing the solvent spinning technique. The spinning solutions were prepared from 23 wt% of PVDF in DMAC and different concentrations of ethylene glycol [8].

Minghao Gu (2006) revealed the polymer diluents mixture was dissolved for 4 h at about 453 K. Then the mixture was quenched in air for 20 min, yielding a solid polymer diluents sample. After reheating in an oven for 10 min at 453 K, it was taken out to quench in the water bath [9].

Guo-dong Kang (2014) applied that the hydrophilic modification of PVDF membranes can be achieved during preparation process, e.g., the introduction of hydrophilic modifiers by blending. The hydrophilic modifiers can be mainly classified into two categories polymer material and inorganic nanoparticle [10].

Dongliang Wang (2000) proposed that Polyvinylidene fluoride was used in pallet form Dimethylacetamide (DMAC) was used as the solvent. The additives used include water, ethanol, 1-propanol and LiCl.Water, ethanol and a mixture of water and ethanol was used as the internal coagulant. Tap water was used as the external coagulant [11].

S.P. Deshmukh (1998) had studied the degassed PVDF dope was transferred to a stainless steel reservoir and pressurised to 20±30 psig using nitrogen. A tube-in-orifice spinneret with orifice diameter/inner diameter of the tube of 1.0/0.22 mm was used to obtain hollow fibre membranes. The air gap was kept at 18 cm for all the spinning runs. Water was used as an internal coagulant for all spinning runs, but external coagulation bath composition was varied from 0% to 50% (v/v) of ethanol in water. Finally, forming hollow fibre was passed through water bath to complete solidification process and thoroughly washed in water [12].

B. Characterization of hollow fibre membranes.

J.M. Ortiz (1995) de zarate had suggested the main characterization technique is the flux measurement. In order to measure the MD fluxes, a double cell apparatus was used. The membrane is placed in PVC holder between two stainless steel chambers filled with bidistilled water. It was observed that the temperature difference between both liquid phases was always 1 K lower than the one programmed in the thermostats [13].

Nana Li (2010) had assessed in order to examine the compatibility of PVDF/PVA simply; the casting polymer solutions were prepared by dissolving polymer in DMSO at various blending ratios of PVDF/PVA without PEG. The structure and morphology of membranes were observed by SEM (Quanta 200, FEI, Neth. The cross-section of membranes was freeze-fractured under liquid nitrogen. The membrane samples were gold sputtered and analyzed using SEM [14].

C.Y. Feng (2012) had done atomic force microscopy (AFM) has been widely used to study the morphology of membrane surfaceNodule aggregat es are aligned to the direction of bore fluid flow, forming small rows of nodule aggregat e. The average size of the nodule aggregate is 63 nm and the average length of the row is 224 nm for 0.1 ml/min. On the other hand, the average size of the nodule aggregates is 84 nm and the average length of the row is 601.9 nm for 0.4 bore fluid rate. [15].

Toru Ishigami (2014) said that a stress control rheometer was used to measure the rheological characteristics. The viscosity and first normal stress difference of the polymer solutions were measured with a cone-and-plate geometry (cone diameter, 50 mm; angle, 1°). The pre-shear (shear rate, 1 s−1; shearing time, 60 s) was applied to obtain a uniform initial state. The shear rate was then varied from 1 to 1000 s−1 [16].

M.R. Moghareh Abed (2012) analysed the Fourier transform infrared attenuated total reflectance (FTIRATR) was used to determine the surface composition of the spun hollow fibres. In the tensiometer method, the cross-section of the hollow fibre was sealed by epoxy resin in order to prevent the adsorption of water into the lumen, and the contact angle was measured using a tensiometer [17].

C. Performance of hollow fibre membranes.

Huyan Shi (2013) had investigated the water flux was mainly determined by the membrane morphology but Although zeolites were adhered to the fingers of hollow fiber membrane , it will not block the water channel due to the relatively low content and micro porous structure of zeolites [18].

Daqing Tong (2016) had studied hydrophobicity, which influencing LEPw, is one of important factors for stability of MD process. The membrane was fabricated with the coating time, heat-treatment time and heat-treatment temperature of 10 min, 5 h and 50 ^{o}C, respectively. For MD process, it has been theoretically and experimentally proven that porosity plays a key role to the performance of MD membrane [19].

M.R. Moghareh (2012) Abed had compared to commonly used PVDF solvents, such as NMP or DMAC, TEP can be considered as a relatively weaker solvent for PVDF. However, PVDF can be dissolved in TEP at 80 ◦C to form a clear and homogeneous solution. The viscosity of the solution changes when the solution is cooled down to room temperature and eventually the solution becomes gel. In order to monitor the gelation process, the temperature and viscosity of the solution was monitored with time. The viscosity behaviour with time and temperature of three different PVDF/TEP solutions with and without the PEG additive [20].

Ngoc Lieu Le (2017) suggests that Different coagulants have been investigated in this study to fabricate porous hollow fibers, which include common coagulants – the non-solvent water and the mixture of solvent and non-solvent (NMP and water) – and newly proposed coagulants – EG and their mixture with water. The nature of coagulants contributes to govern the precipitation rate of the polymer dope, which is an important parameter for fabricating porous membranes [21].

III. CONCLUSION AND FUTURE SCOPE

In this review paper, the discussion had been done about the various methods employed for the preparation of hollow fibre membrane. Further, various characterization techniques like atomic force microscopy, scanning electron microscope and FTIRATR had been studied. A review on the composite hollow fibres has also been done to extract some useful facts regarding water flux measurement. The conclusions drawn from the literature review are listed below:

The hollow fibre membranes (HT1–HT3) spun from the PVDF/TEP solution did not show any water flux but reveal excellent mechanical properties due to the formation of thick dense skin layer.

Hyflon AD60/PVDF composite hollow fiber membrane was fabricated by coating Hyflon AD60 on PVDF hollow fiber membrane and results indicated that Hyflon AD60/PVDF composite membrane is. an excellent candidate for MD process.

An antibacterial PVDF hollow fibre membrane. was successfully prepared via dry-jet wet-spinning technique by doping Ag-loaded zeolites.

The amphiphilic copolymer PVDF-g-POEM was synthesised using an ATRP method. Flux recovery of over 95% after the BSA fouling was achieved by washing the membranes with water indicating that the fouling resistance of. the modified hollow fibre membranes improved considerably.

Based on the conclusions drawn from the above literature review, the following works related to the hollow fibre membrane can be taken up in future.

The analysis can be done with. different concentrations of PVDF and. other composite material.

The different types of characterization techniques. like porosimetry can. be analyzed.

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