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Performance and characteristics study of $PES/ZrSiO_4$ and PES/SiO_2 membrane for tannery and textile effluent treatment

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The solution for water scarcity problem can be accomplished by treating the domestic & industrial wastewater with different treatment techniques. In this study, Polyethersulfone (PES) membranes were prepared with 0%, 0.25%, 0.5%, 0.75% and 1% wt% of SiO_2 and $ZrSiO_4$ as two different modifying agents. Phase inversion method is used for membrane preparation with N-methyl pyrolidone (NMP) as a solvent and Sodium Lauryl Sulphate (SLS) and water mixture as a non-solvent. The morphology and pore size were analysed by Scanning Electron Microscopy (SEM). The crystallinity was verified with the help of X-Ray Diffraction Techniques (XRD) and the identification of organic and inorganic groups were done using Fourier Transform Infra-Red Spectroscopy (FTIR). The pure water flux rate analysis was carried out for all the membrane with vacuum filtration setup. The performance of the different membranes was analysed with tannery effluent and textile effluent. SEM image shows a two-layered structure where the top surface is porous followed with the homogeneous bottom surface membrane. The pore size and number of pores increased with the addition of inorganic materials. The results show that the moderate reduction in Total Suspended Solids (TSS), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Dissolved Solids (TDS), chlorides etc.

Keyw ords: Polyethersulfone, Mixed Matrix Membrane, Filtration, Textile effluent, Tannery effluent.

Introduction

Water scarcity is one of the significant challenges of the modern human society. The earth receives its fresh water supply in the form of rain which gets transferred as the resources such as River, Lake, Pond and ground water. Throughout the history, this fresh water from these resources is consumed mainly for domestic and agricultural purposes. In India, Population explosion over the recent years has increased this water demand. Also, majority of this fresh water is consumed by industry & other commercial activities beyond drinking after industrialization. This rising demand of fresh water has put a major stress on water resources across the world particularly in India [1, 2].

Also, the current generation finds it difficult to reduce their water consumption patterns because of their modern lifestyle. The principle of 3R's (Reduce, Reuse, and Recycle) can be used to help to overcome this water scarcity. The used water or wastewater can be utilized for reuse and recycle. The estimated sewage generation in India is higher than the level of treated water from the sewage treatment plants. Central Pollution Control Board of India states in their report in 2015 that the total wastewater generated is 61754 Million Litres per Day (MLD) but only 22963MLD wastewater can be treated. Due to the hiatus in the sewage treatment, about 38,791 MLD of untreated water is discharged into the nearby water sources.

The different parameters such as pH, TDS, chloride, iron, Nitrogen, Sulphates, Lead, etc., in the treated water has to be maintained up to the standards before consumption. Otherwise, it will lead to health problems. So, treating this wastewater before consuming is very much important.

Industrial effluent water also needs to be treated before discharging into any water bodies. Nowadays treating the tannery effluent and textile effluent is challenging due to the presence of high organic and inorganic substances. The emerging pollutants like pesticides, dyes, metals, etc., should also be removed from the wastewater. Contaminants removal can be achieved by using different treatment techniques like (Sedimentation, Aeration, Adsorption, Reverse Osmosis, and Filtration, etc.).

Membranes have been used for a long time for separation processes in diverse fields [3, 4]. Moderate amount of contaminants removal can be achieved through the membrane filtration techniques. This membrane separation technique has many advantages in comparison to conventional treatment processes. Nowadays research is needed for obtaining the membranes

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with better performance based on the specific requirement. Microfiltration, Ultrafiltration, and nanofiltration are different membrane filtration techniques. Ultrafiltration method is used for the water recycle and reuse effectively. Extra energy in the form of heat and new material usage is not required for this kind of treatment. Phase change is also not involved in this process. It separates the particles from the range of 0.001 μm to 0.02 μm. 90% of the contaminants removal can be achieved with the help of membrane filtration techniques. It removes both macromolecules and colloidal particles simultaneously. Membranes can be prepared by using different materials like Polymer, Ceramic, and polymer combined with ceramic. So, the development of the materials is essential to fabricate the membrane [5-8].

Of these, polymeric membranes serve a significant role in their specificity, stability, and availability. Cellulose acetate, Polyethersulfone, Polypropylene, and Polysulfone are the basic polymeric material. Polyethersulfone (PES) Ultrafiltration membrane is highly feasible for effluent treatment because of its high flexibility, appreciable mechanical, chemical, hydrolytic and thermal properties [7, 9]. The performance of the polymeric membranes is limited by some of the intrinsic properties of the polymers. However, rapid progress has been happening in the field of membranes where polymeric membranes are replaced by mixed matrix membranes comprising more than one constituent. The ceramic materials are the possible alternate source since it has high durability, large mechanical strength, high resistance power against pH, oxidation, chemicals & solvents and high thermal stability.

Ceramic materials like Zircosil, Quartz, Sodium feldspar, Nanoclay, Alumina, Titania and Wollastonite can be used for this membrane preparation. The particle size of these materials is preferred to have Micro or Nano size because of their high surface area, stability, improved absorption/adsorption properties. The researches proved that the ceramic membrane has more advantages, but the fabrication is a little bit difficult, so the cost of the membrane is on the higher side [10, 11].

To overcome these issues the research had made the attempt in the 1980s with the combination of polymer and ceramic material (mixed matrix membranes) [12, 13]. The combinations of polymers (usually in bulk phase) with inorganic materials (in dispersed phase) to make a more efficient membrane Mixed Matrix Membrane (MMM) with better mechanical and thermal properties to extend the field of applications. Other merits encompass Anti-fouling capacity, superior separation characteristics and exceptional selectivity. The MMMs do overcome the limitations of its individual constituent properties like the fragility of ceramic and less thermal stability of polymers. The ceramic additives are used to obtain the unique properties in the membrane-like pore formation, pore interconnectivity, and hydrophilicity. A small amount of additive is enough to improve the membrane characteristics. N-methyl pyrolidone, Polyvinylpyrolidone, Polyethylene glycols, and anhydrous lithium chloride are some common additives which can be used as a common additive. But the product will not be proper with high quantity addition of additives. So, it should be limited.

The dry phase inversion technique is highly used in the fabrication of the mixed matrix membrane [14-16]. In this fabrication Phase Inversion is carried out through immersing the polymer solution into the solvent. This technique could be carried out by reducing the solution's temperature, immersing the polymer in anti-solvent or by evaporating the solvent.

In this study, PES (PolyEtherSulfone), the polymeric material, is chosen for its particularity, flexibility, better permeability, processing ease, market availability and it has excellent mechanical, thermal, electrical and chemical properties [17, 18]. It is one of the most used polymers in the field of membrane synthesis for its distinguishing characteristics (high productivity, processability, and hydrophilicity while blending with other polymers and ceramic) [19]. PES flat sheet UltraFiltration membrane (UF) is proven as an economically feasible material for membrane preparation in the tannery effluent treatment [20].

Asaeda M.J et al. has prepared the membranes with the ceramic (SiO_2) material separately and mixed with the polymer (PES) to form the matrix membrane. Silica-based membranes are used in membrane preparation. Size-dependent molecular filtration processes need micro and nano-sized particles. By using silica sol deposition on the alumina support, the microporous membrane was prepared, and it is used for helium removal. It produces better performance [21]. Zr doped Silica membrane gives better performance compared with pure silica membrane for Hydrogen selectivity [22]. So, Silicate form of Zirconium ($ZrSiO_4$) is used in this research work as a ceramic material. In this Series of PES/$ZrSiO_4$ and PES/SiO_2 membranes were created with different weight ratio. Due to that the membrane will get some extra characteristics like pore size, pore distribution, flux rate, long-lasting capacity, withstand high pressure and withstand in high temperature. XRD, FTIR and SEM tests were carried out for these membranes. The results obtained in this work shows that the PES/$ZrSiO_4$ and PES/SiO_2 membranes are giving better efficiency in the removal of contaminants.

Materials Involved

The following materials are used for membrane preparation. Commercial Grade Polyethersulfone (PES) [MW:58000 g/mol] as the polymer. SiO_2 & $ZrSiO_4$ are used as inorganic materials. N-methyl pyrolidone (NMP) as a solvent and Sodium Lauryl sulphate and water mixture as a non-solvent are used. They are

purchased from Techinc. pvt. Ltd., Chennai. PES preferred because of its high temperature (150 °C) withstanding capacity and this one will withstand in pH range of 2-13. The size of the inorganic materials varies from 100-300 nm. The tannery effluent and textile industry effluent are collected from the industries which are placed in and around Hosur. Flat sheet membrane preparation equipment (Made: Techinc. Pvt. Ltd.,) was used for the membrane preparation.

Methodology

Preparation of PES/SiO_2 and PES/$ZrSiO_4$ membrane

- The Homogenous membrane solution is prepared by adding the PES with the NMP. The polymer material is allowed to dissolve in the solvent NMP. 15% (wt %) of PES is combined with the 85% (wt %) of NMP and then it is subjected to continuous stirring at about 400 rpm overnight as shown in Fig. 1 for complete dissolution of the polymer into the solvent (also to prevent clustering).
- With the same kind of procedure, the ceramic materials (SiO_2 & $ZrSiO_4$) are added separately in weight percentage of 0.25% with the homogeneous polymer solution after the preparation of the homogenous solution and kept stirring for another 8 hours.

The percentage of PES added in the process is reduced for the upcoming membranes with the addition of ceramic materials. The details of the materials proportion in wt% are shown in Table 1 & 2.

Then the membrane solution is allowed for the removal of air bubbles (45 min).

- The solution is cast automatically with the help of flat sheet membrane preparation equipment as shown in Fig. 2. The blades are used to maintain the constant thickness of the membrane.

Fig. 1. Preparation of Homogeneous (polymer + inorganic) Solution.

- The coated glass plate is dipped into the distilled water and SLS mixture for 10 minutes. In that time the solvents which are present in the membrane will dissolve in the distilled water. The membranes are coded for the identification purpose.
- Finally, the membranes were put to various tests to find the characteristics and performance of the respective membrane.

Membrane characterization

Scanning Electron Microscope (SEM)

The membranes were cut into a small piece (5 mm*5

Table 1. Hydrophilicty of PES/$ZrSiO_4$ membrane

Membrane code	NMP (wt% = 85%) (ml)	PES+$ZrSiO_4$ (wt % = 15%)	
		PESwt% (g)	$ZrSiO_4$wt% (g)
A-Z	20	15% (3.529 g)	0% (0 g)
A-Z-A	20	14.75% (3.471 g)	0.25% (0.059 g)
A-Z-B	20	14.5%(3.411 g)	0.5% (0.117 g)
A-Z-C	20	14.25% (3.35 g)	0.75% (0.176 g)
A-Z-D	20	14% (3.294 g)	1% (0.243 g)

Table 2. Hydrophilicty of PES/SiO_2 membrane

Membrane code	NMP (wt% = 85%) (ml)	PES+ SiO_2(wt %= 15%)	
		PESwt% (g)	SiO_2wt% (g)
A-Z	20	15% (3.529 g)	0% (0 g)
P-Q-1	20	14.75% (3.471 g)	0.25% (0.059 g)
P-Q-2	20	14.5% (3.411 g)	0.5% (0.117 g)
P-Q-3	20	14.25% (3.35 g)	0.75% (0.176 g)
P-Q-4	20	14% (3.294 g)	1% (0.243 g)

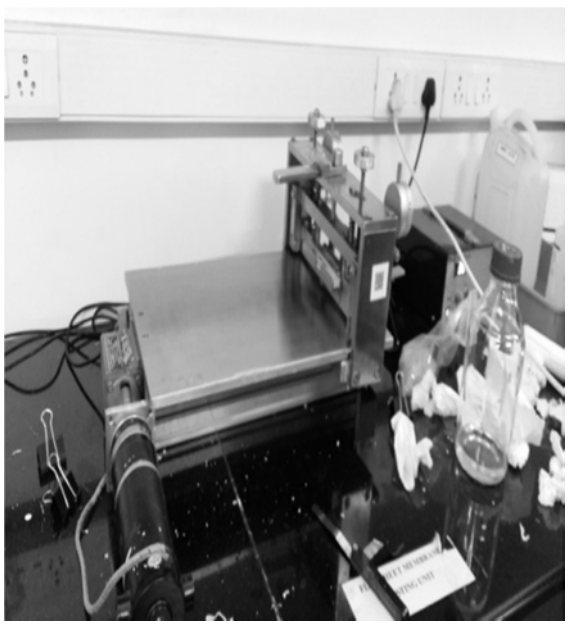

Fig. 2. Casting equipment for the flat sheet membrane.

mm) for the SEM test analysis. The morphology of the membranes was studied using SEM (S-3000H; HITACHI make). The formation of pores in the membranes and estimation of pore sizes can be analysed by using SEM analysis. The cross-sectional area and the top surface of the membrane also can be figured out from this test. While doing the SEM test with the top surface, that top surface was ion sputtered. It was done to avoid charging.

X-Ray Diffraction Test (XRD)

XRD (XRD 6000; SHIMADZU make) was used. By using this, the average bulk composition can be determined. It is used to find the crystallinity by comparing the integrated intensity of the background pattern to that of the sharp peaks. XRD patterns were studied for pure PES, PES/SiO_2 and PES/$ZrSiO_4$ membranes.

Fourier Transform Infra-Red Spectroscopy (FTIR) test

Membrane samples are given to the FTIR (IR Prestige-21 model; SHIMADZU make) for the functional group identification.

Percentage of water uptake

To find this water uptake and porosity percentage, first, the membranes were cut into small piece and soaked in water for one whole day. After removing from the water, the weight was taken W_1 and the Weight of the membrane W_2 was taken after drying for 24 hrs. The vacuum oven is used for drying.

$$\% \text{ water uptake} = [(W_1-W_2)/W_1]*100$$

Where,

W_1 = weight of membrane at wet state,

W_2 = weight of membrane at dry state,

ρ = density of water,

V = volume of membrane at wet state.

Vacuum filtration

The membranes were cut into a small circle with the radius of 2 cm for the filtration setup. The suction is the driving force from the vacuum pump. The vacuum pump creates suction pressure on the bottom bottle. Due to that, the water starts to permeate through the membrane. 20 ml of distilled water used to test the flux rate or permeation rate of various membranes. The different time value was noted down.

Flux = Volume /(Cross-sectional area*time)

The different water quality parameters were tested for the effluent before and after treatment. Ultrafiltration assembly is used to perform the filtration. The pressure maintaining in this experiment is approximately 400 kPa. The membrane was washed before taking into the performance test and set on the steel base.

Results & Discussions:

Flux rate

Pure water is used in this system as a feed to measure the flux rate for the membranes. This steady was carried out with the transmembrane pressure of 400kPa for the various composition of PES/SiO_2 and PES/$ZrSiO_4$ membrane. The comparative graph is shown in Fig. 3 as mentioned above. This curve shows that the time taken for pure PES is high and for the increase in SiO_2 & $ZrSiO_4$ composition in PES, the time taken was reduced. This result concludes that the membrane resistance got reduced. When compared with $ZrSiO_4$, SiO_2 TOOK a lower time for the same composition of 1%, and the flux rate was increased. Effect of $ZrSiO_4$ & SiO_2 on flux rate is listed in Table 3.

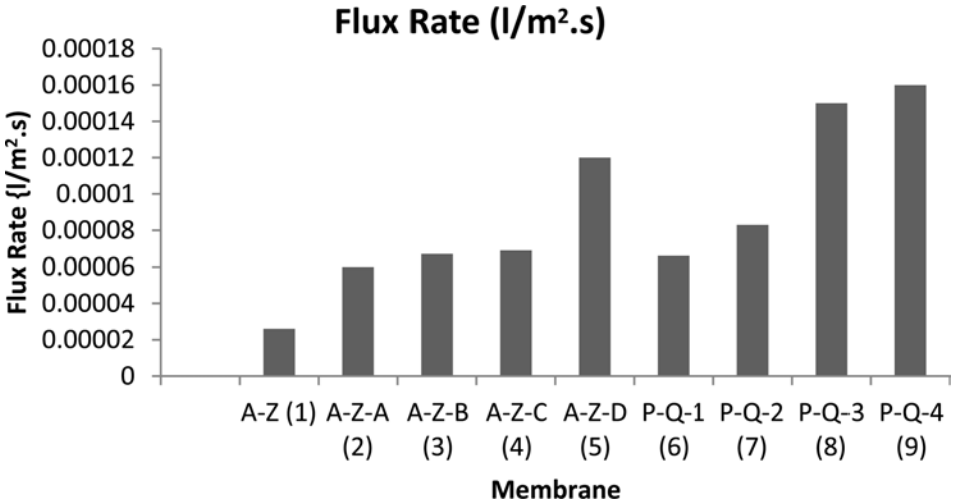

Fig. 3. Graphical comparison for flux rate of different membranes.

Effect of PES/$ZrSiO_4$ and PES/SiO_2 on water content

The flux behaviour can be measured by water content. Same like this the hydrophilicity of the membrane can be studied with the help of water content study. So the water content was measured for the different composition of PES/SiO_2 and PES/$ZrSiO_4$ membrane. While increasing the $ZrSiO_4$ composition, the water content of the membrane got decreased. For 100% PES, the water content value is 77%. It got reduced to 75.1% after the addition of 1% of $ZrSiO_4$ with PES. While increasing the SiO_2 composition, the water content of the membrane got decreased. For 100% PES, the water content value is 77%. It got reduced to 75.6% after the addition of 1% of SiO_2 with PES. With this, it is clearly reported that the $ZrSiO_4$ addition with the PES gives a better water content reduction.

Fourier transform infrared spectroscopy test pattern

FTIR spectra of Pure PES (P-Z) membrane, PES/SiO_2 (P-Q-4) membrane and PES/$ZrSiO_4$ (A-Z-D) Membranes are shown in the Fig. 4-7. It shows the significant change in the spectrum with the addition of SiO_2 & $ZrSiO_4$ with PES separately.

Table 3. Effect of SiO_2 & $ZrSiO_4$ on water flux

Membrane Name	Time taken (min)	Volume of water sample taken (ml)	Surface Area of the membrane (m^2)	Flux Rate ($l/m^2.s$)
A-Z (1)	100	20	0.1256	0.000026
A-Z-A (2)	44	20	0.1256	0.000060
A-Z-B (3)	39.20	20	0.1256	0.000067
A-Z-C (4)	38.10	20	0.1256	0.000069
A-Z-D (5)	21.30	20	0.1256	0.00012
P-Q-1 (6)	40.10	20	0.1256	0.000066
P-Q-2 (7)	32	20	0.1256	0.000083
P-Q-3 (8)	17.40	20	0.1256	0.00015
P-Q-4 (9)	16.15	20	0.1256	0.00016

From this Fig. 4, it was observed that C-I bond stretching at 476 cm^{-1}, 439 cm^{-1} & 414 cm^{-1}, C-Br & C-Cl bond stretching at 535 cm^{-1}, 609 cm^{-1}, 638 cm^{-1}, 751 cm^{-1} & 765 cm^{-1} and =C-H bond bending at 893 cm^{-1}, C-O bond peaking at 1023 cm^{-1} and 1185 cm^{-1}, C-O-C stretching at 1023 cm^{-1}, and C-N stretching at 1348 cm^{-1} and C=O stretching at 1427 cm^{-1}. In Fig. 5, Peaks are attained at same wavenumbers.

In Fig. 5, FTIR spectra of PES/SiO_2 (P-Q-4), the peak attained in a stretched manner around 1700-1800 cm^{-1} and in Fig. 6, FTIR spectra of PES/$ZrSiO_4$ (A-Z-D), the peak intensity is almost nil in the 1700-1800 cm^{-1} wavenumber region. In Fig. 7, it was observed that the functional group peaks intensity is varied for PES/SiO_2 membrane and some peaks are missing between the wavenumber 800-1600 cm^{-1}. Fig. 4 & 5, the peaks are wide in between the wave number of 750-1500 cm^{-1}. In Fig. 6, the wave number 750-780 cm^{-1} peaks were too strong when compare to others. Fig. 7 clearly shows that no functional group variations were attained in the PES/SiO_2 membrane, but the intensity of the functional groups were varied. The membrane A-Z-D lost some of the functional group. The summary of FTIR test was shown in the Table 4.

Unfortunately, the FTIR spectra did not show the presence of ceramic material in the spectrum because the addition of ceramic material with the polymer was small and size of the material was also too small (nano size).

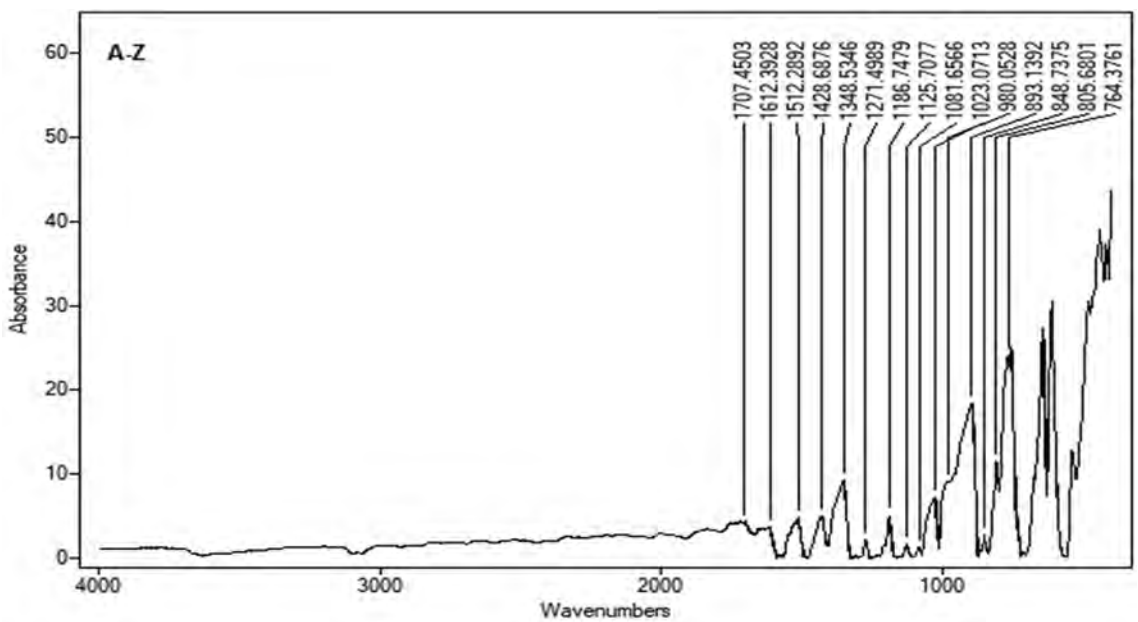

Fig. 4. FTIR spectra of Pure PES (A-Z) membrane.

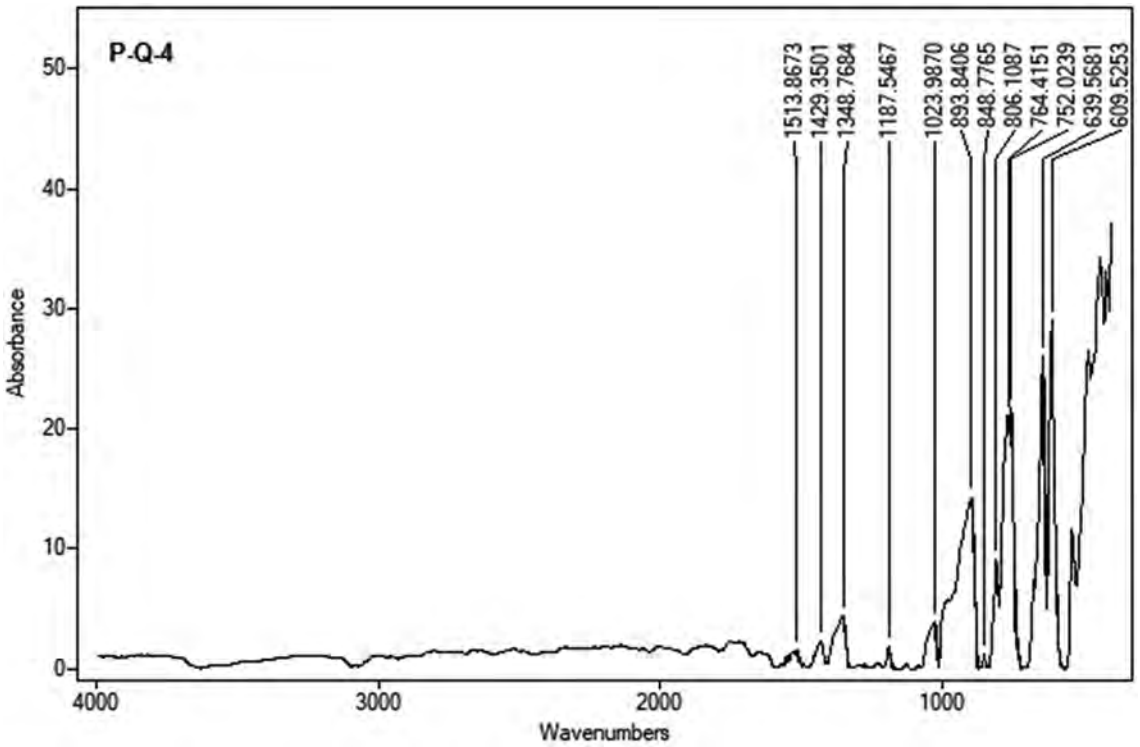

Fig. 5. FTIR spectra of PES/SiO_2 (P-Q-4) membrane.

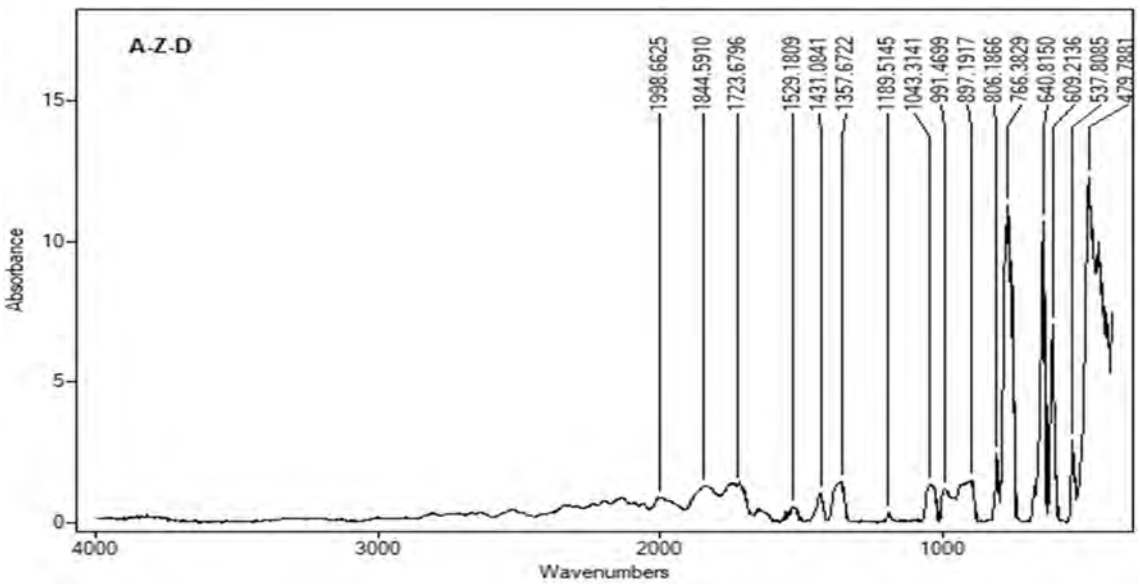

Fig. 6. FTIR spectra of PES/$ZrSiO_4$ (A-Z-D) Membrane.

X-Ray diffraction test pattern

XRD diffraction pattern of PES combined with $ZrSiO_4$ (1%) membrane and PES combined with and SiO_2 (1%) are shown in the Fig. 8. 100% PES Membrane gave single peak and increased in the $ZrSiO_4$ and SiO_2 gave a weak peak, also while comparing the $ZrSiO_4$ and SiO_2, SiO_2 gave a little weaker and broader peak. Here for plain PES membrane the highest peak is obtained with 19.5 degree. The peak was obtained with 19.5 and 27 degree for the 1% of $ZrSiO_4$ with PES membrane. For the 1% SiO_2 the peak was obtained with 19.5 and 27 degree for the 1% of SiO_2 with PES membrane. The XRD pattern showed clearly that the small disturbed peaks in PES+$ZrSiO_4$ rather than the PES+SiO_2 give a plain peak curve. But all the three membranes are in amorphous form. It didn't provide the crystalline structure. Ruchi Nandanwar et al. [23] & Yogendra Pratap singh et al. [24] compared their

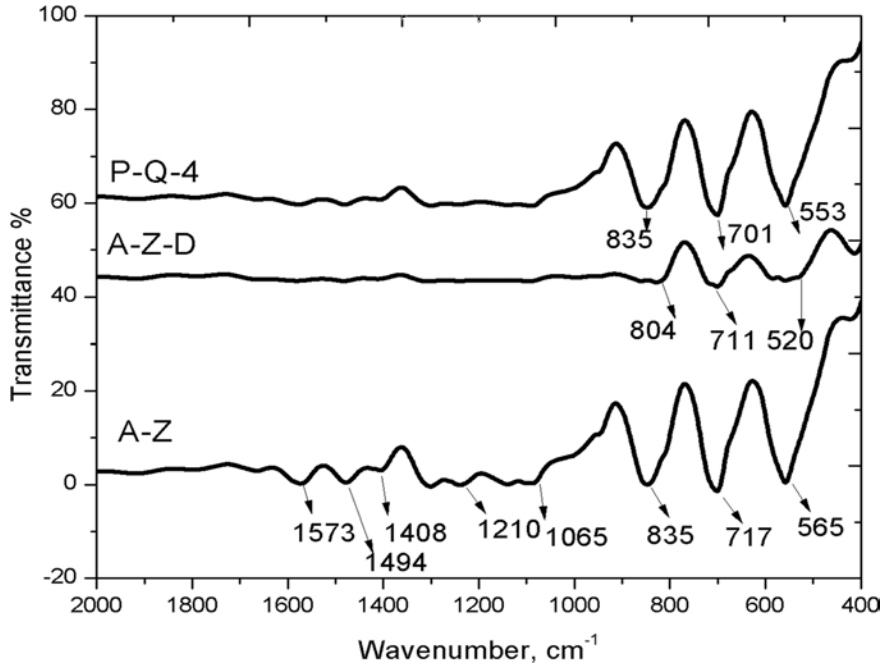

Fig. 7. Combined FTIR spectra of (a) Pure PES (A-Z) membrane, (b) PES/SiO_2 (P-Q-4) membrane, (c) PES/$ZrSiO_4$ (A-Z-D) Membrane.

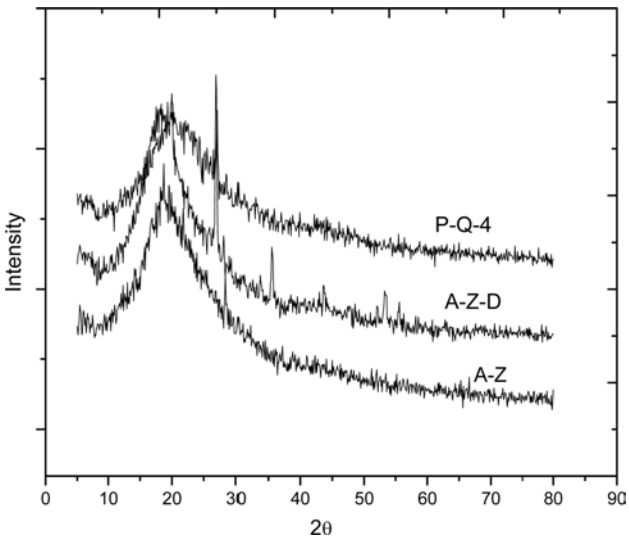

Fig. 8. Combined XRD pattern of A-Z, A-Z-D and P-Q-4.

Table 4. Summary of FTIR Test

Organic Compound	Wave number (cm^{-1})	Functional group
NMP	1427	C-N
	1348	C=O
PES	900-700	Para benzene

obtained pure SiO_2 XRD results with JCPDS card. They concluded that the presence of SiO_2 gives the peaks from the range of 21° to 30°. In this study also, the peaks were obtained in the range of 21° to 30° for PES/$ZrSiO_4$ Membrane and PES/SiO_2 membrane. In plain PES the peak obtained only at 19.5°.

Scanning electron microscopy image

The SEM images of the top surfaces and cross sections of PES/$SiO_2$and PES/$ZrSiO_4$ were shown in the Fig. 9, Fig. 10, Fig. 11 & Fig. 12. These pictures showed that Asymmetric membranes were formed. It showed that a more significant number of pores in the top layer. The pores formation got increased with the addition of ceramic material. The pores were visibly distributed in the top surface of A-Z-A, A-Z-B, A-Z-C, A-Z-D, P-Q-1, P-Q-2, P-Q-3 and P-Q-4. The size of the pores in A-Z-D and P-Q-4 were bigger than that of the pores in A-Z-A, A-Z-B, A-Z-C and P-Q-1, P-Q-2, P-Q-3 respectively. Average pore size was little bit less in $ZrSiO_4$ when compared with the plain SiO_2 addition. The results showed that the SiO_2 and $ZrSiO_4$ addition with the PES played an important role in pore formation.

Performance analysis with PES/SiO_2 and PES/$ZrSiO_4$ membrane

The tannery effluent and textile effluent were collected from the industries which are located near Erode. Before providing into the filtration assembly, pre-chlorination was done for the effluents to avoid fouling. Then this water was given into the conventional treatment (Coagulation with sedimentation) to remove suspended solids. By this action, the clogging of membrane can be avoided. The alum was used for the coagulation. The optimum dose of alum carried out here was 2% (wt/vol). Various important parameters for before and after alum addition were presented in the below table. The suspended solids free water was taken later for the

PES/ $ZrSiO_4$ membraneMorphology/Top Surface and Cross Sectional view:

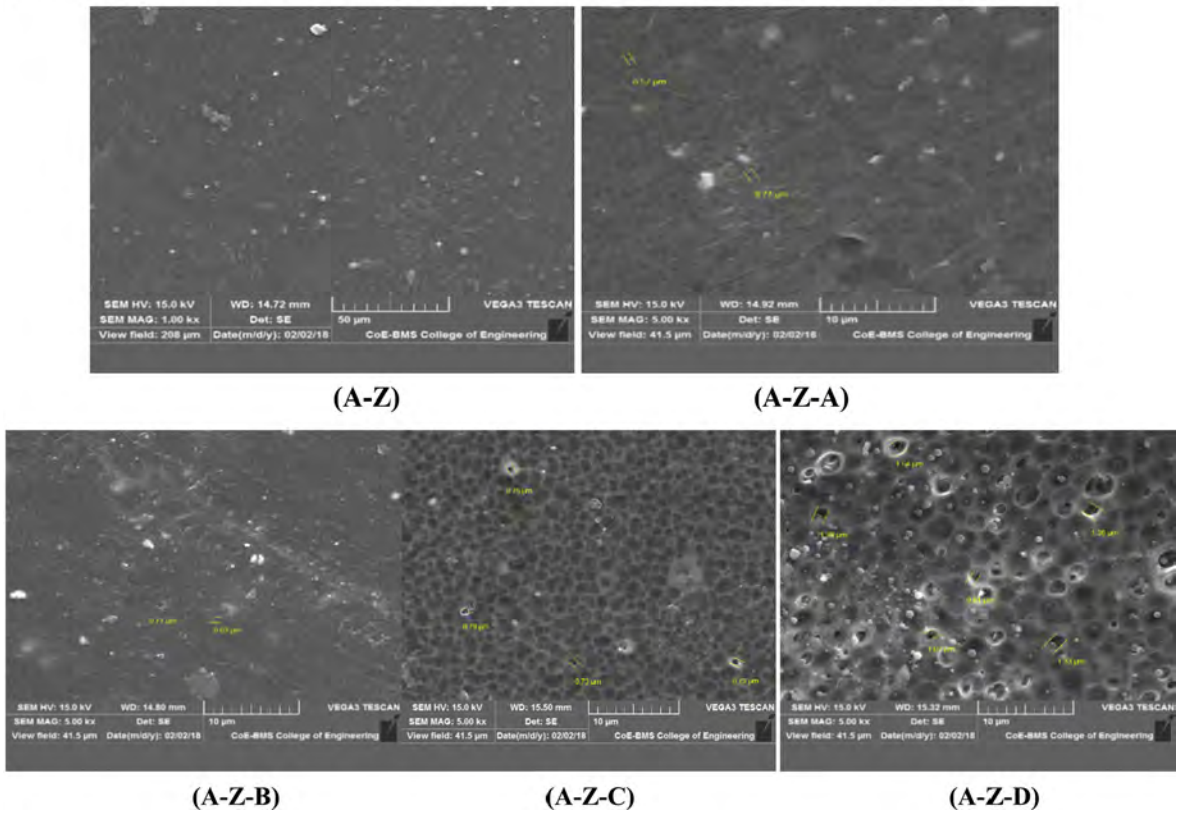

Fig. 9. SEM images of PES/$ZrSiO_4$ membranes – Top surface.

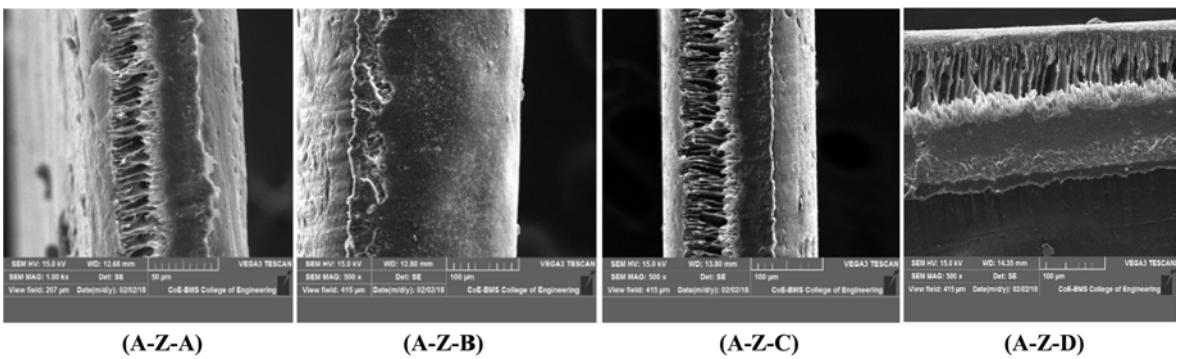

Fig. 10. SEM images of PES/$ZrSiO_4$ membranes – Cross sectional view: (a) A-Z-A, (b) A-Z-B, (c) A-Z-C, (d) A-Z-D.

PES/ SiO_2membraneMorphology/Top Surface and Cross Sectional view::

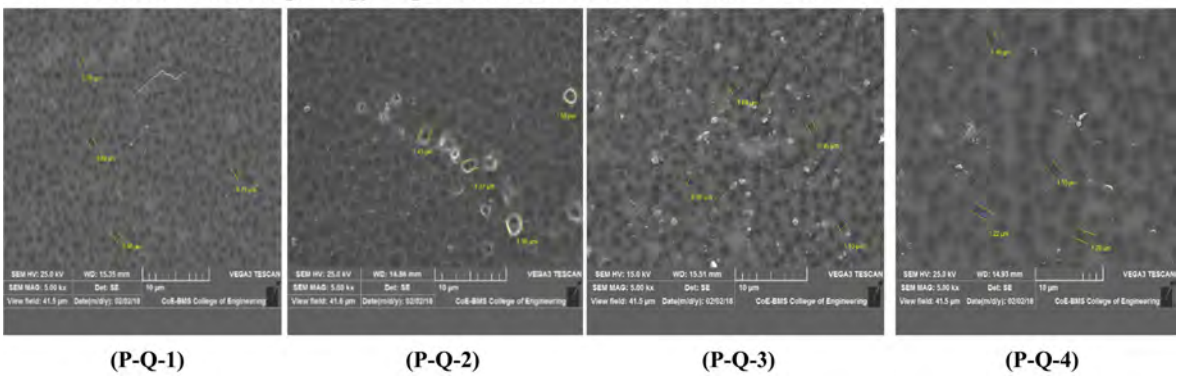

Fig. 11. SEM images of PES/SiO_2 membranes – Top surface.

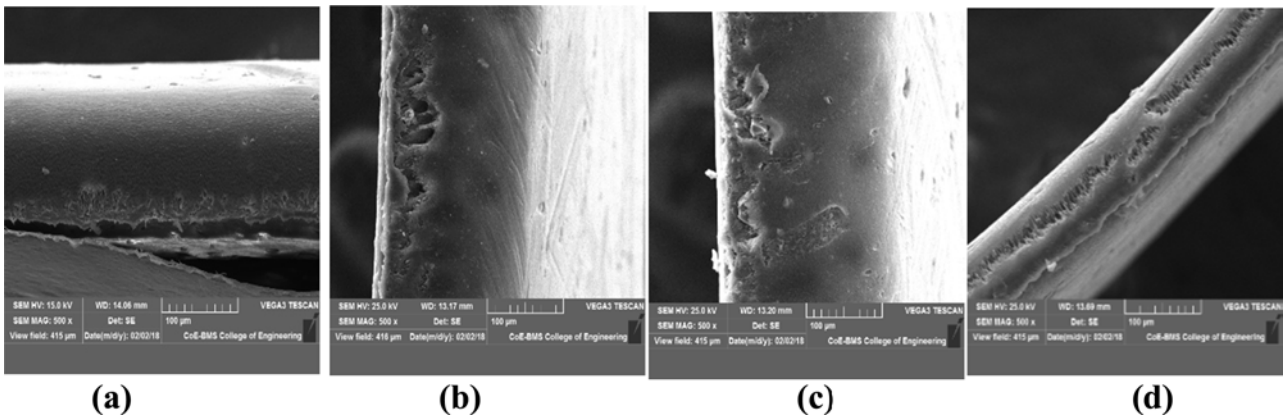

Fig. 12. SEM images of PES/SiO_2 membranes – Cross sectional view: (a) P-Q-1, (b) P-Q-2, (c) P-Q-3, (d) P-Q-4.

Table 5. Different properties of the effluent before and after the coagulation (primary) treatment

S.No	Parameters	Tannery Effluent		Textile Effluent	
		Raw effluent	Primary treated effluent	Raw effluent	Primary treated effluent
1.	pH	9.7	6.8	8.9	6.5
2.	TSS	210	112	110	52
3.	TDS	7450	6105	6100	4600
4.	COD	3600	1620	1760	780
5.	BOD	1250	475	510	220
10.	Colour	Yellow	Slight yellow	Red	Red

Table 6. Properties of the effluent before and after the membrane treatment.

S.No	Parameters	Tannery Effluent				Textile Effluent			
		Primary treated effluent	Treated effluent			Primary t reated effluent	Treated effluent		
			A-Z	P-Q-4	A-Z-D		A-Z	P-Q-4	A-Z-D
1.	pH	6.8	6.8	6.8	6.8	6.5	6.5	6.5	6.7
2.	TSS	112	71	47	38	52	34	26	28
3.	TDS	6105	5120	3400	2100	4600	2560	2350	2620
4.	COD	1620	615	380	310	780	510	470	452
5.	BOD	475	91	64	45	220	102	96	84
6.	Sulfide	65	27	21	18	47	18	12	10
7.	Chromium	6.1	3.4	2.1	1.8	1.2	0.7	0.5	0.5
8.	Chloride	1750	1375	925	695	820	665	610	544
9.	Ammoniacal Nitrogen	78	45	26	23	45	32	29	29
10.	Colour	Slight yellow	Yellow trace	Yellow trace	Yellow trace	Red	Slight red	Slight red	Slight red

performance study of the membrane. The colour was removed, and the other contaminants also removed while using the PES/$ZrSiO_4$ and PES/SiO_2 membrane. When compared with two membranes the PES/SiO_2 gave the better result. The different properties of the effluent before and after were tabulated in Table 5 & 6.

Membrane suitability depends on the permeate quality. From the result, it was clearly concluded that the TSS reduction was achieved 37% by 100% PES membrane, but 1% PES/SiO_2 membrane gave 58% reduction of TSS and 1% PES/$ZrSiO_4$ membrane gave 66% reduction of TSS. 100% PES membrane reduced 16% TDS only, but 1% PES/SiO_2 membrane gave 44% reduction of TDS and 1% PES/$ZrSiO_4$ membrane gave 66% reduction of TDS. Same like the TSS and TDS reduction, the other parameters such as COD, BOD, Chloride also reduced. From the result, it was concluded that PES/$ZrSiO_4$ gave better removal efficiency when compared to PES/SiO_2.

Conclusion

The PES/$ZrSiO_4$ and PES/SiO_2 membranes performance study was carried out with tannery and textile wastewater treatment. The morphology of the membrane varied with the change in the concentration of the $ZrSiO_4$ and

SiO_2 addition with the PES. The hydrophobic nature of the membrane was confirmed with the water uptake. A flux rate was linearly increased with the addition of $ZrSiO_4$ and SiO_2. The performance characteristics of the membranes were tested and checked with the standards. The obtained results gave acceptable results as per standards. The pore size of the membrane was almost in a uniform condition. These results gave reinforcement that the membrane PES/$ZrSiO_4$ and PES/SiO_2 could be used for water and wastewater treatment. With the derived result, it was concluded that the PES/$ZrSiO_4$ membrane gives better performance when compared to with PES/SiO_2 membrane. PES/$ZrSiO_4$ membrane doesn't have some of the functional group's peaks comparing with PES membrane (A-Z). This may be the reason to get better performance with PES/$ZrSiO_4$ membrane. The results showed that the ceramic material could be used as a replacing material in the membrane preparation to increase the performance of the membrane. The work can be done in the future with the high quantity of ceramic material in the place of polymeric material as a modifying agent.

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