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Elaboration of Polymeric Membranes using Phase Inversion Technique for the Removal of Particulate Matter (PM) from Air

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ABSTRACT

Air pollution, particularly the presence of fine particulate matter (PM) pollutants, poses a significant environmental and public health threat. Recent research has placed a substantial focus on membrane technology as an effective filtration method to capture organic compounds emitted from industrial sites. In our investigation, we concentrated on the development of polymeric membranes utilizing the phase inversion technique. This method entails dissolving polymer solutions such as PMMA and TAC in chloroform, with the added modification of incorporating specific plasticizers. The membranes created were characterized using scanning electron microscopy, Fourier-transform infrared spectroscopy, and thermogravimetric analysis. The $PM_{2.5}$ samples were collected on the achieved membranes (TAC-based membranes) to assess their efficiency with that of Polytetrafluoroethylene (PTFE) filters, during a 24-hour sampling at an industrial site known for its high levels of pollution.

Keywords: Membranes; PTFE, PMMA; TAC; $PM_{2,5}$; Industrial site

1 Introduction

The presence of fine particle matter (PM) pollutants in the air is a major environmental concern that poses serious risks to the public's health and the environment **[1]**. Recently, membrane technology has become a focal point in numerous studies, attracting considerable attention from researchers and experts alike **[2].** This technology is being studied as a potential efficient filtration technique for removing organic compounds released from industrial locations to reduce their harmful effects on both environmental quality and public health **[3].** Our research focused on developing sophisticated polymeric membranes with a porous structure and well-defined pore size using the phase inversion technique.

2 Experimental

2.1 Membrane synthesis

Polymeric membranes were prepared using the procedure described elsewhere by Sugiura **[4].** In this method, 0.5 g of TAC were dissolved in 40 ml of Chloroform and stirred for 4 hours. Then 0.3 ml of dioctyl phthalate (DOP) and 0.3 ml of the complexant tris-(2-ethylhexyl) phosphate (TEHP) were added successively under vigorous stirring. The homogeneous solution was transferred into a circular glass container and left for slow evaporation over 24 hours at room temperature. Subsequently, the resulting membrane was extracted using water.

2.2 Sampling

We conducted a 24-hour sampling of fine particulate matter ($PM_{2.5}$) starting at 10:00 h in the morning using two medium volume pumps (MVS) situated within an industrial site known for its high pollution levels, the $PM_{2.5}$ samples were collected on (TAC-based membranes) and Polytetrafluoroethylene (PTFE)

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3 Results and Discussion

FTIR spectroscopy was used to detect the frequency variations of the functional groups of cellulose triacetate (TAC) membrane. Fig 2 illustrates the appearance of bands at 1270 cm^{-1} and 1040 cm^{-1} indicate the presence of elongation vibrations of asymmetric and symmetrical groups (C-O-C). A band located at 1729 cm^{-1} is attributed to stretching vibrations of the carbonyl group of the ester function of the polymer. Symmetrical and asymmetric C-H elongation vibration bands are observed in the dominant (2870 cm^{-1} - 2965 cm^{-1}).

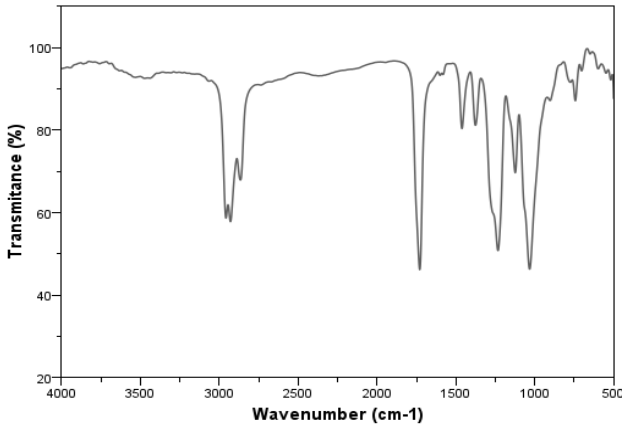

Figure 1: FTIR spectrum of the TAC membrane

4 Conclusions

We employed physical characterization methods, including FTIR, TGA, and SEM, to analyze the synthesized membranes. FTIR spectroscopy verified the coexistence of all components within each membrane and confirmed the formation of hydrogen-bonding interactions among them. This analysis provided valuable insights into the structural and chemical properties of the synthesized membranes.

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