VOCs and particles removal with TiO_2 Fibers prepared by electrospinning

Tasi-Yu Yang[1], Nhat Thien Nguyen[2] and Chang-Tang Chang[1,*]

[1] Department of Environmental Engineering, National I-Lan University, I-Lan, 26047, Taiwan
[2] Institute of Environmental Engineering and Management, National Taipei University of Technology, Taipei, 10608, Taiwan
Keywords: Electrospinning, Polyacrylonitrile, Volatile organic compounds, Particles
Presenting author email: ctchang@niu.edu.tw

The generation of particulate pollutants and volatile organic compounds (VOCs) has a close relationship with human activities. Combustion process or vehicle emissions will produce particles. In modern semiconductor and photovoltaic industry, a lot of VOCs will be generated during producing process due to using organic solvent, such as acetone. Acetone and particles cause dangerous for ecology, environment and human health. Many studies have explored how to remove VOCs from water or air. These methods suffer from some problems, such as low removal efficiency and high costs. Titanium dioxide, a photosensitive semiconductors, can absorb ultraviolet light to form reactive hydroxyl radicals. These free radicals undertake a series of reactions with pollutants, such as containing bond cleavage, substitution, and electron transfer, to mineralize them into CO_2 and water.Fine particles, as one of the most serious sources of air pollution, turned out to be a major cause of adverse health effects ranging from human respiratory tract to extra pulmonary organs. At present, the nonwoven filter medium based on conventional fibers usually suffer from many performance disadvantages, such as relatively low filtration efficiency and high energy consumption, as well as unsuitable for the capture of fine particles due to the micro-sized fiber diameter.
Cho et al. (2013) reported the achievement of excellent air filtration efficiency and maintain low pressure drop by covering the substrate with polymeric nanofibers containing metal oxide nano particles, which can strongly influence electrostatic interactions between dust particles and nanofibers.

In this study, Titanium dioxide Polyacrylonitrile fibers (TPF) by the introduction of TiO_2 nanoparticle with increasing filtration performance and promoting photodegradation of volatile organic compounds. The combination of TiO_2 nanoparticle could create hierarchical roughness on the membrane surface, which shows great influence on the morphology, surface wetability, and porous structure of the resultant membranes. In the other hand, TPF showed excellent photocatalytic activity superior to the electrospun pure PF.The physical and chemical properties of photocatalysts were indicated with spectrophotometer (UV-vis), X-ray diffractometer (XRD), Fourier-Transform Infrared Spectrometer (FTIR), Scanning Electron Microscope (SEM). This study has been successfully prepared TPF and the optimum TiO_2 content fiber is 2% TPF. The degradation efficiency can be up to 90% under the initial acetone concentration of 400 ppm, the residence time of 50 min. The filtration performance results showed that titanium dioxide was added to improve the filter quality. The penetration of 2% TPF could be smaller than 1.9 %.The results of simultaneous pollutants removal test are shown in Figure 1. It display that the performance of filter does not be affected significantly when the VOCs and particles were removed simultaneously.Photocatalytic results are shown in Figure 2. The photocatalytic efficiency decreased with increasing operating time. After one hour, there were no significant differences between the photocatalytic efficiency with particles and without particles. In contrast, the photocatalytic efficiency with particles was obviously decreased after eight hours. The reason is that UV light was blocked by the particles on the surface of the filter. It leads to obtain low photocatalytic efficiency.

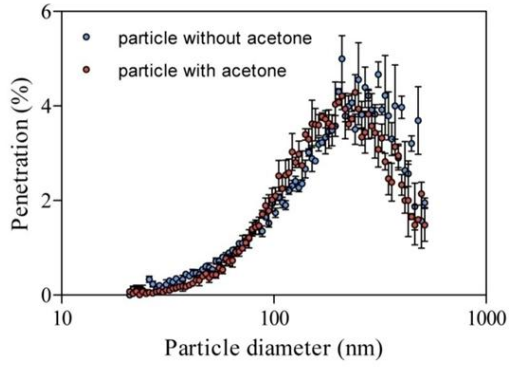

Figure 1. The influence of acetone on particle removal

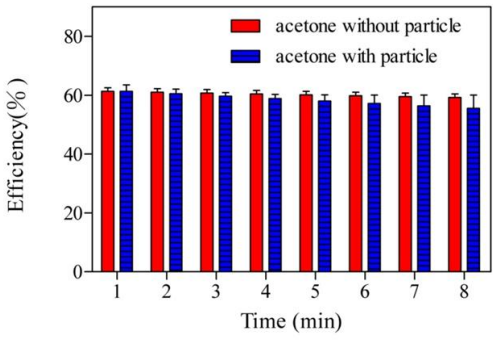

Figure 2. The influence of particle on acetone removal.

Cho, D., Naydich, A., Frey, M. W., and Joo, Y. L. (2013), *Polymer*,54(9), 2364-2372.