Evaluation of Optimal Performance of Activated Carbon filter media Coated with PAN Nanofibers

Sedigheh Borhani, Seyed Abdolkarim Hosseini Ravandi*, Mohammad Morshed, Siamak Almassi, Amirhossein Salehi and Golamreza Etemad

Center of Excellence for Environmental Nanotechnology, Isfahan University of Technology, Isfahan, Iran
Milad Industrial Factory
* hoseinir@cc.iut.ac.ir

1. Introduction

Electrospun nanofibers have broad applications in composite nonwoven structures in traditional markets. Electrospun nanofibers are being considered for variety of applications where their unique properties contribute to product functionality. Those properties include high surface area, small fiber diameter, potential to incorporate active chemistry, filtration properties, layer thinness, high permeability, low weight and can be formed into sheet structures with very high porosity [1-4].

A Composite nanofiber filter media consisting of electrospun nanofibers in combination with a wet-laid substrate material has been successfully used since 1981 in Ultra-Web filter cartridges in a wide range of industrial, consumer and defense filtration applications [1]. Filters nanofibers-based membranes are capable of filtering and separating blood, water, air, beverages, gases, chemicals, oils, paints, etc., while at the same time absorbing harmful volatile organic compounds and toxic gases [1, 2]. Researchers are currently exploring additional nanofiber composite designs for several new uses including providing a highly permeable aerosol barrier in protective gear such as facemasks, medical gowns and drapes, and protective clothing applications. Nanofibers are a natural candidate for such applications, as high air permeability is desired to improve user comfort, and high aerosol efficiency is needed to provide adequate protection from aerosolized [1].

This paper will discuss the incorporation of electrospun nanofibers into an activated carbon filter media for protective applications. The web characteristics are tailored to achieve the desired filter performance and gas permeability by varying fiber diameter and fiber- packing fraction within the nanoweb.

2. Experimental

Materials: Industrial polyacrylonitrile (PAN) with weight average molecular weight $\left(\overline{M}_w\right)$ and number average molecular weight $\left(\overline{M}_n\right)$ of 100000 and 70000 respectively was obtained from Iran Polyacryle Co. Dimethyleformamide(DMF) was obtained from Merck. Activated carbon filter was obtained from Milad Industrial Factory.

Processing and Measurements: Solutions from 11, 13, 15 wt% PAN in DMF were prepared. The electrospinning setup used in this study consisted of a syringe and needle with outside diameter of 0.7mm, a ground electrode (a drum with variable rotational speed and diameter of 5cm which covered with Al. sheet), and high-voltage supply with direct current voltages up to 25 kV. The distance between the needle tip and the ground electrode was 15 cm. The voltage used in this research was 10 kV. PAN solutions were delivered via a syringe pump with mass flow rate of $2.98\,\mu l/\min$ Rotational speed of drum ranged from 18 to 54 RPM. All electrospinnings were carried out at $25^{\circ}C$.

The nanofibers were collected from a solution of PAN in DMF in the form of a nonwoven mat on the surface of activated carbon filter media.

Samples of the nanofiber were tested to determine changes in weight, fibers diameter, benzene absorption, 1, 3-DCP(1, 3- dicholoro poropan) and air permeability.

3. Results and discussion