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Controlling Toluene pollution using synthesized polyaniline/clay nanocomposite

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KEYWORDS

Polyaniline nanocomposites, toluene adsorption, air pollution

SHORT SUMMARY

Toluene (C_6H_5-CH_3) is a pollutant that may cause serious health hazards. One of the popular methods to control it is by adsorption using polymeric nanocomposites. In this study, nanocomposites were synthesized by polymerizing aniline, assisted by the use of CO_2, without (PANI) or with (PANC) the use of clay. Both were thoroughly characterized and tested as an adsorbent in a fixed bed. Three inlet concentrations were experimented, (150- 500- 700 ppm). The results revealed a strong adsorption performance of both materials, with a slight advantage for the affinity of PANI towards C_6H_5-CH_3 vapor compared to that of PANC (320 and 162 mg C_6H_5-CH_3/ gm adsorbent for PANI and PANC respectively). Hence, nanostructured PANI and PANC can be promising adsorbents for controlling different gaseous air pollutants.

EXTENDED ABSTRACT

Toluene has been identified in about half the National Priorities List (NPL) of sites having known hazardous risks of pollutants release in the US [1]. Adsorption is a known method to eliminate such pollutants in air, which is gaining more popularity. This is due to its high efficiency, low budget and its ecofriendly nature [2]. Polyaniline (PANI) and its nanocomposites have been extensively used as an adsorbent for removing contaminants especially from aqueous solutions [3], or in gas sensing [4]. However, little interest was paid for it as an adsorbent in air pollution control. Recently, polyaniline nanotubes have been prepared and experimented to remove C_6H_5-CH_3 from air using fixed bed reactor [5]. Although the adsorption parameters were limited but the nanotubular structure of PANI showed high removal efficiency for the studied gases.

In this study PANI and PANC were synthesized using CO_2-assisted polymerization technique. The prepared adsorbents were characterized using Fourier transform infrared spectroscopy (FTIR), X-ray diffraction (XRD), Transmission electron microscopy (TEM), Scanning Electron Microscope (SEM) and Brunner Emmett Teller (BET). The synthesized nanostructured materials were experimented as adsorbents to remove C_6H_5-CH_3 from simulated polluted air stream.

It was found that the morphology of the prepared nanostructured materials was nanorod like structures with average diameter of about (80 nm) in case of PANI. TEM images revealed full separation of clay gallery within polyaniline chains and the average diameter was about (60 nm). The synthesized nanostructured materials were tested to remove gaseous pollutants from air (C_6H_5-CH_3). The obtained adsorption capacities were high. The affinity of PANI toward C_6H_5-CH_3 vapor was better than PANC affinity (320 and 162 mg C_6H_5-CH_3/ gm adsorbent for PANI and PANC respectively) for 150 ppm inlet C_6H_5-CH_3concentration. It can be concluded that PANI and PANC are good candidates to remove hazardous pollutants from air.

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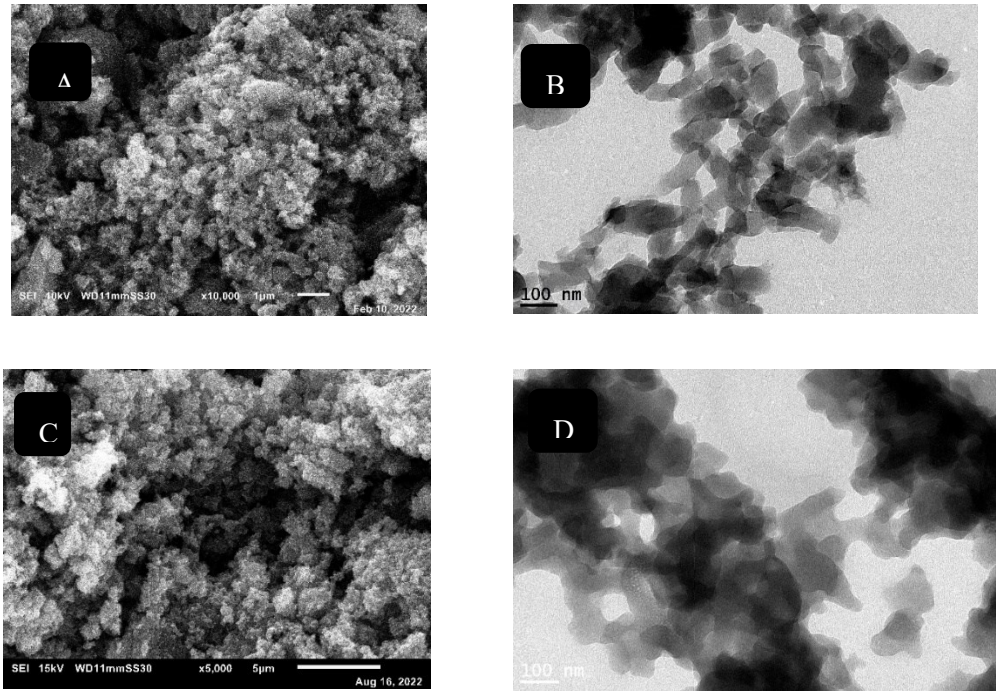

Figure 1. SEM and TEM images for PANI (1.A, 1.B) and PANC (1.C, 1.D) respectively.

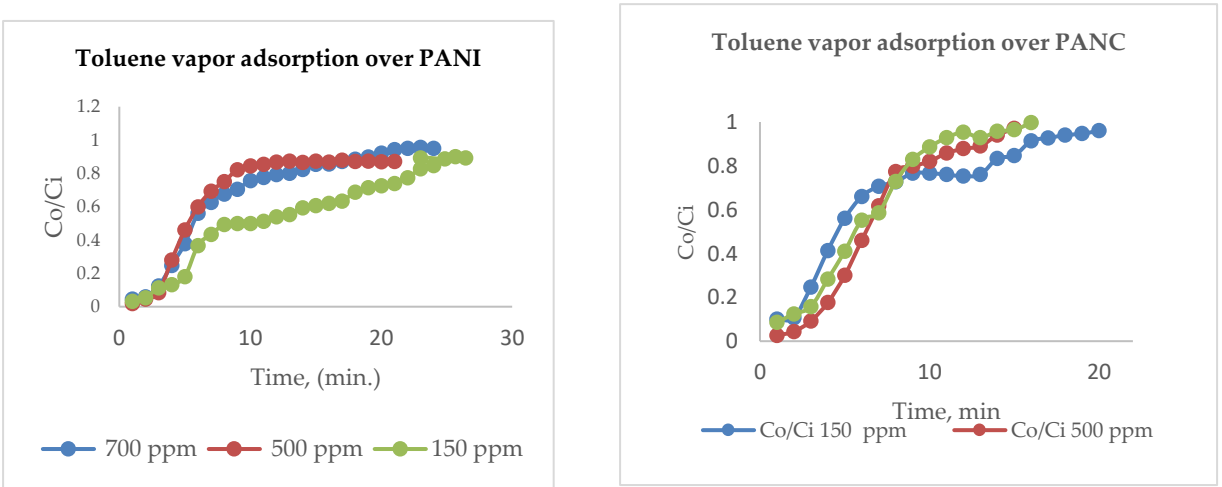

Figure 2. Breakthrough curves for toluene removal over PANI and PANC at different inlet gas (150 -700 ppm).