

Removal of Aldehydes and HCN from Cigarette Smoke Using Amino Acid Ionic Liquids

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Abstract

Small molecular aldehydes and hydrogen cyanide (HCN) are important harmful components in cigarette smoke, which also significantly contribute to its irritancy. Therefore, reducing the yield of aldehydes and HCN in cigarette smoke is of great significance for public health and the improvement of cigarette product. In this study, a series of tetrapropylammonium hydroxide-amino acid ionic liquids (TPAILs) were prepared via a simple acid-base neutralization reaction to selectively reduce the release of aldehydes and HCN in cigarette smoke. These TPAILs were systematically characterized by Fourier transform infrared spectroscopy (FTIR), nuclear magnetic resonance spectroscopy (NMR), and elemental analysis (EA); the thermal stability was further evaluated with thermogravimetric analysis (TG). The adsorption capacity of the prepared TPAILs toward aldehydes and HCN was assessed in a homemade simulated filtration device under controlled conditions. The adsorption performance was notably affected by both the type of amino acid used and the dosage of TPAILs applied. With the increasing of the pendent chain length of the amino acid, the removal efficiency of acetaldehyde and crotonaldehyde decreased significantly from 32%, 66% to 16%, 41%, respectively, which can be primarily attributed to the increased steric hindrance imposed by the longer side chains. Interestingly, TPAILs bearing pendant amino groups, such as [N3333][Lys], exhibited enhanced adsorption performance, reducing about 60% of crotonaldehyde and 39% of acetaldehyde due to the strong chemisorption interaction between the pendant amino groups and the aldehyde molecules. In addition, more than 90% of HCN, 80% of formaldehyde, and 50% of acrolein could be efficiently removed by these TPAILs under the optimized conditions. Collectively, these results clearly demonstrate the significant filtration performance of TPAILs as effective absorbents for removing harmful aldehydes and HCN from cigarette smoke.

Keywords

Amino Acid Ionic Liquid, Cigarette Smoke, Adsorption, Aldehydes, Hydrogen Cyanide