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Reduction of Nitrogen Monoxide with Carbon Monoxide from Gas Streams by 10% wt. Cu-Ce-Fe-Co/Activated Carbon

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Abstract : Nitrogen oxides (NO_x) is regarded as one of the most important air pollutants. It not only causes adverse environmental effects but also harms human lungs and respiratory system. As a post-combustion treatment, selective catalytic reduction (SCR) possess the highest NO removal efficiency (≥ 85%), which is considered as the most effective technique for removing NO from gas streams. However, injection of reducing agent such as NH_3 is requested, and it is costly and may cause secondary pollution. Reduction of NO with carbon monoxide (CO) as reducing agent has been previously investigated. In this process, the key step involves the NO adsorption and dissociation. Also, the high performance mainly relies on the amounts of oxygen vacancy on catalyst surface and redox ability of catalyst, because oxygen vacancy can activate the N-O bond to promote its dissociation. Additionally, perfect redox ability can promote the adsorption of NO and oxidation of CO. Typically, noble metals such as iridium (Ir), platinum (Pt), and palladium (Pd) are used as catalyst for the reduction of NO with CO; however, high cost has limited their applications. Recently, transition metal oxides have been investigated for the reduction of NO with CO, especially Cu_xOy, Co_xOy, Fe_2O_3, and MnO_x are considered as effective catalysts. However, deactivation is inevitable as oxygen (O_2) exists in the gas streams because active sites (oxygen vacancies) of catalyst are occupied by O_2. In this study, Cu-Ce-Fe-Co is prepared and supported on activated carbon by impregnation method to form 10% wt. Cu-Ce-Fe-Co/activated carbon catalyst. Generally, addition of activated carbon on catalyst can bring several advantages: (1) NO can be effectively adsorbed by interaction between catalyst and activated carbon, resulting in the improvement of NO removal, (2) direct NO decomposition may be achieved over carbon associated with catalyst, and (3) reduction of NO could be enhanced by a reducing agent over carbon-supported catalyst. Therefore, 10% wt. Cu-Ce-Fe-Co/activated carbon may have better performance for reduction of NO with CO. Experimental results indicate that NO conversion achieved with 10% wt. Cu-Ce-Fe-Co/activated carbon reaches 83% at 150°C with 300 ppm NO and 10,000 ppm CO. As temperature is further increased to 200°C, 100% NO conversion could be achieved, implying that 10% wt. Cu-Ce-Fe-Co/activated carbon prepared has good activity for the reduction of NO with CO. In order to investigate the effect of O_2 on reduction of NO with CO, 1-5% O_2 are introduced into the system. The results indicate that NO conversions still maintain at ≥ 90% with 1-5% O_2 conditions at 200°C. It is worth noting that effect of O_2 on reduction of NO with CO could be significantly improved as carbon is used as support. It is inferred that carbon support can react with O_2 to produce CO_2 as O_2 exists in the gas streams. Overall, 10% wt. Cu-Ce-Fe-Co/activated carbon is demonstrated with good potential for reduction of NO with CO, and possible mechanisms will be elucidated in this paper.

Keywords : nitrogen oxides (NO_x), carbon monoxide (CO), reduction of NO with CO, carbon material, catalysis
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