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Multi-pollutant Control of NO and Hg^0 with Reduced Graphene Oxide Modified CeO_2/TiO_2 for Low-temperature NH_3-SCR

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Extended Abstract

Nitric oxide (NO) and elemental mercury (Hg^0) are major toxic pollutants in flue gas emissions from coal-fired power plants, posing serious environmental and health risks. Traditional removal methods such as NH_3-SCR using V-W-based catalysts suffer from several drawbacks, including toxicity, narrow temperature windows, and low N_2 selectivity. Similarly, common Hg^0 removal strategies like adsorbent injection face issues such as short lifespan and regeneration needs. This study developed reduced graphene oxide (rGO)-modified CeO_2/TiO_2 (GCT) catalysts prepared via an ultrasound-assisted impregnation method to the simultaneous photothermal catalytic remove NO and Hg^0 Hydrothermal and ultrasound-assisted impregnation method (GCT-H and GCT-I) were compared.

The catalysts were synthesized using hydrothermal and ultrasonic-assisted impregnation methods to investigate which is the suitable approach to synthesize. The catalysts were evaluated by the lab scale catalytic reaction system, composed of gas cylinder, mass flow control meter, mixing chamber, temperature control device, and the catalytic reactor made up of quartz glass. The reaction temperature was set in the range of 100℃-250℃ while the gas velocity was controlled at around 10,000 h^{-1} [1].

Surface characterization analysis including XRD, SEM, TEM, BET, Raman, FTIR, XPS, and TPR/TPD were conducted to reveal the chemical and physical properties of GCT-H and GCT-I. The rGO modification significantly increased specific surface area (SSA) and pore volume, improving adsorption and catalytic activity. The SSA of GCT-H and GCT-I were 133 m^2/g and 69 m^2/g, respectively, which were higher than that of CeO_2/TiO_2. The increase in SSA provides more adsorption sites for Hg^0, NO, and NH_3. The structural differences between synthesis methods were also elucidated by SEM and TEM. CeO_2 particle in the GCT-I presented mainly on the surface of rGO while it presented at the edge of rGO when using the hydrothermal method. Element mapping analysis showed that Ce and Ti uniformly distribute on the catalysts. XRD showed that TiO_2 presented as anatase and CeO_2 was cubic fluorite presented as low-intensity diffraction peaks contributed by the low amount of Ce. In addition, GCT-I reduces the crystallinity of TiO_2, thus decreasing the size of TiO_2.

The NO reduction efficiency of CeO_2/TiO_2 was 0% at 100℃, remains below 10% at 150℃ and 200℃, and rises to approximately 90% at 250℃, indicating the small operation temperature window. For 5G7CT-I, efficiency begins at around 60-70% at 100°C, and peaks near 100% at 150℃, 200℃, and 250℃. For 5G7CT-H, efficiency is below 10% at 100℃, increases to about 10% at 150℃, rises to around 60% at 200℃, and maintains approximately 60% at 250℃. The Hg^0 oxidation efficiency of CeO_2/TiO_2, 5G7CT-I, and 5G7CT-H at 200℃ were 70%, 89%, and 80%, respectively. The results showed that 5G7CT-I exhibits a higher value to be applied in the application in the coal-fired power plants.

This study demonstrates that ultrasound-assisted impregnation is a viable, cost-effective method for producing efficient, low-Ce-content GCT catalysts with dual functionality for NO and Hg^0 removal. The approach provides a scalable pathway for the development of high-performance, durable catalysts suitable for industrial air pollution control systems, especially under moist and SO_2-rich environments.

References

[1] J.-R. Zheng, C.-S. Yuan, I.-R. Ie, and H. Shen, "S-scheme heterojunction CeO_2/TiO_2 modified by reduced graphene oxide (rGO) as charge transfer route for integrated photothermal catalytic oxidation of Hg^0," *Fuel,* vol. 343, p. 127973, 2023/07/01/ 2023, doi: https://doi.org/10.1016/j.fuel.2023.127973.